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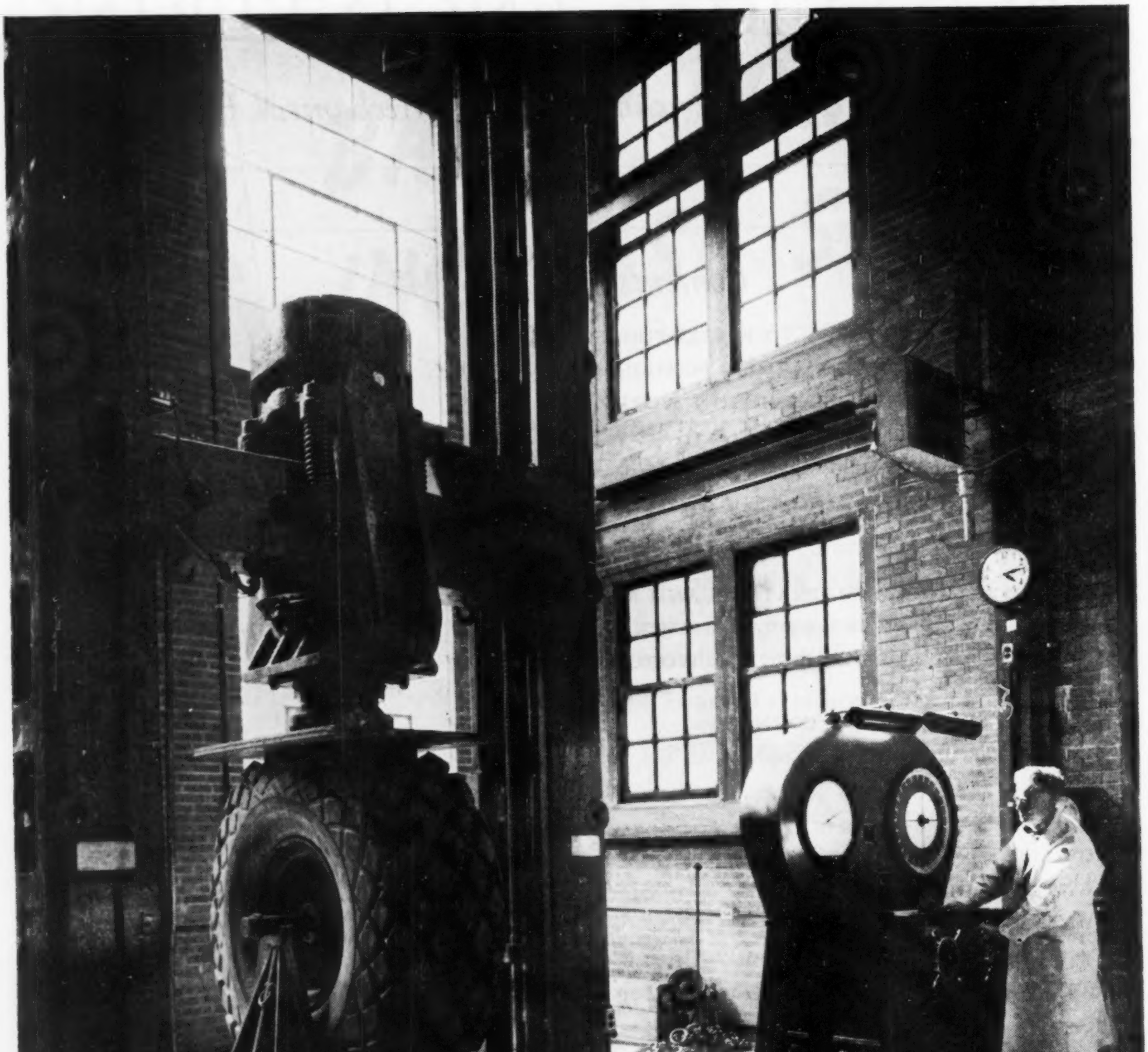

Large Tire-Testing Machine at Goodrich Tire and Rubber Company's Plant

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GEORGE A. STETSON, *Editor*

George T. Seabury

WHAT manner of man was George T. Seabury who died on May 25, for twenty years secretary of the American Society of Civil Engineers and for much of that time dean of engineering-society secretaries in the United States? Short, slender, with thinning hair, level steady eyes behind rimless spectacles, fair, clean-shaven, with a straight mouth that curled up on the right side when he smiled, he was a man of quiet dignity whose conservative dress was never awry. His voice lacked volume; was persuasive rather than commanding; at times, animated and buoyant, at others, unemotional and businesslike. For in him nature contrived to combine the contradictions of New England reticence and austerity with a warm friendliness and generous human impulses. The frankness of his speech was tempered by an astute diplomacy. His pleasures were not in athletics but in the quiet pursuits of simple living. He enjoyed the company of his friends. In convivial surroundings he would relax, tell stories, and throw his head back in wholehearted laughter, or punctuate an apt phrase with a snap of the fingers. When his less restrained constituents in the sections laid care aside, he entered into the spirit of their horseplay and good-naturedly let them make him the butt of their jokes. This thoroughgoing humanness won for him affection without loss of respect.

Energy without noisy and tiring bustle, enthusiasm and sincerity without affectation, intellectual and physical courage without braggadocio, frankness without malice, precision without pedantry in expression, were the qualities he brought to the conduct of his affairs. Wisdom, seasoned with experience, guided his judgments and his counsels.

Seabury possessed the engineering characteristic of realistic planning. He could think objectively about himself and his job. One sensed that he viewed retirement from the secretaryship as a matter of obligation and wise policy and not as an opportunity for greater leisure. In a letter to the Board of Direction asking to be relieved of the secretaryship on his sixty-fifth birthday he wrote: "I have given all that was in me to give . . . It has been an arduous job and I have thoroughly enjoyed it, but . . . I should give none other than my best years to it." It was apparent to his friends that he faced an emotional conflict over the problem of giving what aid and counsel he could to his successor without standing in the other's light or giving the impression of wishing to influence actions or decisions. It was apparent also that the warmhearted friendly Seabury was in conflict with the impersonal objective alter ego with its selfless sense of obligation to the greater good. This dilemma had been happily resolved by the action of the Board of Direction which was loath to lose Seabury's experience and wisdom and hence had created for him the post of assistant to the president. Scarcely more than a week before Seabury's successor took up the responsibilities of the secretaryship, Death itself intervened.

The twenty years during which Seabury served as secretary of the American Society of Civil Engineers were critical ones for that society and for the Nation. They included the reconversion period which followed World War I, the great depression of the 1930's in which engineers experienced greater hardship and unemployment than ever before in their history, the era of made work and extensive public works projects, the fiasco of the N.R.A., the intense activity in construction that accompanied preparedness and national defense programs, and the global war in which we are still engaged.

In the affairs of engineering societies these same years saw the rise and fall of the American Engineering Council, the organization of the Engineers' Council for Professional Development, the formation of the Joint Conference Committee of presidents and secretaries of the Founder Societies (now known as the Engineers' Joint Council), the almost complete acceptance of engineering licensure, comprehensive studies of the economic status of engineers, vigorous action for the relief of unemployed engineers, incorporation and extension of the Engineering Societies Personnel Service, Inc., constant struggles to upgrade engineering fees and salaries, and vexatious developments in collective bargaining for engineering employees. Those two decades from 1925 to 1945 were also marked by steady and gratifying growth of membership of the American Society of Civil Engineers, stability of its financial structure, the attainment of harmony and a progressive co-operative attitude in its management, and the initiation and successful development of a monthly magazine, *Civil Engineering*, to supplement the technical publications, *Proceedings* and Transactions, issued by the society.

In these and other events of the years covered by his secretaryship, Seabury played an important part, and although he scrupulously maintained the relationship of "servant" to the Board of Direction and the committees of the Society, persons who knew him well must confess that his wisdom, intelligence, experience, and knowledge of men and affairs were powerful influences in the formation as well as the administration of society policies. Nor was his influence confined to the society he served as secretary; it was felt and gratefully acknowledged by sister societies and their officers and by other organizations in which members of the engineering profession hold common interests.

A profound sense of personal loss, deep affection, and grateful appreciation of wise counsel frequently asked

and never denied make it difficult for the writer of this appraisal and tribute to treat the subject with the restraint and objectivity which Seabury himself would demand. To one who was close to Seabury during the twenty years of his secretaryship yet sufficiently remote from the immediate environment in which his work was done, the greatest factor in Seabury's life was his powerful influence, frequently exerted in the face of criticism, in the welfare of civil engineers. One could not always agree with him and would sometimes be astonished at views and opinions that disclosed the conflicting emotions of realism and idealism in his nature, but one never questioned his courage, his integrity, and his sincerity. For oneself, for Seabury, and for his friends and family, one regrets his sudden death which robbed him of the satisfactions of an old age with its less strenuous tasks and its less onerous responsibilities. One regrets also that the suddenness of his going forestalled the high tribute in perpetuity to his memory that honorary membership in the society to which he gave so much of himself would have been.

At the height of his career, with his prestige as a faithful servant and leader unimpaired, Seabury had the wisdom and courage to step down, unwilling to give any but the best years of his life to the task he performed so well. Twenty fruitful years of the history of the American Society of Civil Engineers will constitute his monument.

25 *Years of Aviation Division*

THE current year marks the twenty-fifth anniversary of the Aviation Division of The American Society of Mechanical Engineers, and in commemoration of this event the division has recently issued a modest folder, "A Quarter Century of Service to Aviation."

In spite of advances made in aviation during World War I, there was hardly at its close what could be termed an aviation industry of commercial importance. A few pioneer manufacturers of airplanes, engines, accessories, and instruments; some enthusiasts whom Time has vindicated; a scattering of scientists, engineers, and teachers who built wind tunnels, tested models, developed and expanded aerodynamic theory, stress analysis, and the fundamentals of obtaining the maximum strength with the minimum weight and investigated the properties of new materials; aviators who risked their lives and in many cases lost them but whose dramatic exploits served to stimulate popular interest and to generate an increasing degree of faith in the commercial possibilities and practicability of flying and air transportation—provided the nucleus from which has grown one of the largest and most important of the new arts and industries which have revolutionized warfare, practically eliminated time and space as agelong barriers of isolation and usher in a new era of international relations, foreign trade, and global and domestic travel.

A sufficient number of engineers with vision and interest to seek some forum for interchange of the essential knowledge of aviation found in The American Society of Mechanical Engineers a sympathetic understanding of their needs, and under its auspices they organized the Aeronautic Division, today known as the Aviation Division. The history of the last twenty-five years and the publications of the Society record the progress and growth of this pioneer group. Other groups, some with more narrow and specific interests, others with the purpose of developing the popular, commercial, or military aspects of aviation, have shared in this spectacular growth, but there is glory enough for all. The Aviation Division of the A.S.M.E., with all of its changes of fortune, has come of age with a distinguished record of achievement to its credit and with a broad and vigorous program for future development.

The American Society of Mechanical Engineers was a natural home for aviation. Its traditional interests covered the applied sciences on which aviation is based and the technologies that are of especial importance to it. By tradition a place of incubation for the new industries in the mechanical field and by policy and opportunity devoted to the prolific method of cross-fertilization of ideas through its practices devoted to the holding of meetings, the publication of papers, the stimulation of research, the promulgation of codes of construction and operation, the establishment of standards and the fostering of education and co-operative joint action with other groups, the Society was in a position to offer the encouragement and assistance which its vast resources afforded.

Today, the interests of the Aviation Division are as broad as those of the parent society, if, indeed, they are not broader. How ably the Aviation Division has availed itself of the advantages offered by the Society and how closely it has patterned its own policies and procedures on those of the Society can be seen by referring to the program of one of the Division's meetings—for example, the one held in Los Angeles in May—which lists sessions conducted jointly by the Aviation Division with other Society divisions. So broad are these programs and so varied are the technical subjects discussed that these special groups assume responsibility for the solicitation and review of papers to be presented on topics within the fields of their interests and exercise the authority of recommending for publication such papers as satisfy their standards of excellence.

Who shall predict what the future holds in store for the A.S.M.E. Aviation Division? Of 18,500 members of A.S.M.E., 3500 are registered in the Aviation Division and 2000 indicate that aviation is their major interest. At present production of airplanes and accessory equipment and facilities is at a maximum. The volume of production will fall off sharply as the war draws to its successful completion. Even the most extraordinary growth of civil aviation and private flying cannot produce demands sufficient to maintain present production. But on all fronts, unsolved problems, as well as the natural evolutionary changes of a progressive industry, exist in abundance.

The world has learned to appreciate only too well the military importance of aviation and no nation, least of all the United States, can afford to lag behind progress in developments in aeronautics. The American Society of Mechanical Engineers will be remiss in its responsibility and fail to make the most of its opportunity for service if it does not give unstinting support to its Aviation Division.

Adapting ARMY EQUIPMENT *to* FOREST-FIRE FIGHTING

By C. A. ROWLAND, JR.

MAJOR, AIR CORPS, CHIEF FORESTRY SECTION, EGLIN FIELD, FLORIDA

IN June, 1940, the Choctawhatchee National Forest in northwestern Florida was transferred to the War Department and became the Army Air Forces Proving Ground, with headquarters at Eglin Field. This area, of some half million acres of extremely sandy soil, is principally forested with longleaf pine with scrub-oak understory. The area is characterized by flat ridges which break abruptly to the streams, the majority of which are fed from subterranean sources. On either side of the streams there are comparatively narrow swamps with areas of "flats" adjacent to the larger swamps which are marshy, with a ground cover of wire grass.

Prior to its transfer to the War Department, the U. S. Forest Service had administered this area since 1909. As fire protection had been practiced for many years, the ground cover and litter became extremely rough and susceptible to fire. The scrub oak, prevalent in the understory, had increased both in size and density because of the fire protection.

Forest fires in this area are almost entirely surface fires, but because of the heavy "rough" and wire grass, there is a rapid rate of spread. It was learned by the Forest Service, through years of fire protection, that direct attack with water was the best method of stopping the spread of fires here. Fire-fighting technique naturally developed around water-carrying trucks, followed by men to patrol and "mop up" the numerous snags and debris.

When the War Department took over the area, the fire-detection system was retained and six $^1/_2$-ton two-wheel-drive pickup trucks were procured on which were mounted 120-gal water tanks and Panama fan-belt-driven pumps with the necessary hose and hand tools. These were well-designed units, but with the increase in military operations and the corresponding increase in use of the sand roads and fire lines by heavy trucks, it became impossible to furnish adequate fire protection to the area with these trucks. The fire occurrence was increased by bombing and gunnery missions, despite precautions taken in clearing the ranges and burning off safety zones around them. It became evident that trucks capable of carrying more water, which could traverse the extremely sandy roads and operate on marshy lands, were needed. The fire trucks of the Corps of Engineers were designed for combating structure fires, and the crash trucks were specially designed to fight chemical fires, and regulations prohibited their use for forest fires. The "brush trucks," designed by the Corps of Engineers were inadequate for conditions encountered, as they had only two-wheel drive with exposed pumps and fittings which made them impractical for cross-country use. The pumps furnished more water than was ordinarily needed for local conditions, where a small stream of water which will last for a long period is of prime importance.

In 1941, several available types of standard Ordnance vehicles were test-driven in an effort to determine the best all-round vehicle to convert to a fire-fighting truck to meet the needs of this reservation. It was found that the $1^1/_2$-ton, 4×4 Chevrolet cargo truck, with 7.50-20 tires was the best available vehicle at that time for a heavy-duty forest-fire truck. For a light patrol truck to replace the $^1/_2$-ton two-wheel-drive trucks originally procured, the Ordnance $^1/_2$-ton 4×4 Dodge with metal cab was selected. The Panama pumps in use had given satisfactory service, furnishing sufficient discharge and pressure, so these were used chiefly. The first truck converted was a $1^1/_2$-ton Chevrolet 4×4 cargo truck. Seat frames, tarpaulin, and bows were removed and tanks, with a capacity of 500 gal, and a new Panama pump were mounted on the truck. This unit proved superior to the lighter two-wheel-drive pickup both in its ability to reach inaccessible places and to carry sufficient water to combat large fires.

The advantages of the Army-type vehicles with their rugged construction and four-wheel drive were obvious, so all the fire-fighting equipment was converted to four-wheel drive, and experiments were made with as many types of vehicles and pumps as could be secured, to determine the most effective combination of chassis, pump, water tank, and nozzles. The original $^1/_2$-ton pickups were replaced by 4×4 Ordnance $^1/_2$-ton pickups with 7.50-16 tires, to which the equipment from the two-wheel-drive trucks was transferred. The following report covers the equipment tested:

AUTOCAR HALF-TRACK

An experimental Autocar half-track refueling unit with a 750-gal tank was made available for conversion to a forest-fire-fighting vehicle. The need for this type was particularly evident on fires occurring in wire grass or muck flats, which are not sufficiently firm for most wheel-type vehicles.

The filter was removed from the tank and the inside was painted with black asphaltum paint to prevent rust. Stiffer springs were installed because the original springs were designed for gasoline. The Yale-Towne gasoline pump and Wisconsin auxiliary motor were converted to pump water by setting the pressure to the maximum, as this pump was designed for large volume discharge at a low pressure. Approximately 50 lb pressure could be maintained on two hoses with $^1/_4$-in. nozzle apertures. The gasoline fittings were replaced, and 100 ft of $^3/_4$-in. hose was placed on the live reel for use in reaching inaccessible places. A 10-ft section of 1-in. hose was installed for the "hose man," who stands on the rear platform. Nozzles with $^1/_4$-in. openings were first used, but recent experience has indicated that smaller openings result in better pressure, with greater conservation of water. Using one hose with $^1/_4$-in. nozzle, the tank lasts approximately 1 hr. A 2-in. suction hose and $1^1/_2$-in. filler hose are used when the pump refills the tank from a stream or natural water supply. This vehicle can refill itself in about 20 min.

The half-track is primarily used to furnish heavy reinforcement for fire fighting when it is evident that lighter equipment will not have sufficient water and traction to handle the fire. This unit is considerably slower than the $1^1/_2$-ton cargo truck as its maximum practical speed is 30 mph. It is expensive to operate as the fuel consumption is approximately 4 miles per gal, and tracks have a life of about 2500 miles under local conditions.

CHEVROLET $1^1/_2$-TON CARGO TRUCK

The first vehicle to be adapted was an Ordnance $1^1/_2$-ton 4×4 (2-DT) Chevrolet cargo truck with steel cab and body. Tanks having a capacity of 500 gal were mounted, and a Panama fan-belt-driven water pump with compensating by-

pass was installed. This vehicle is well adapted for use as a heavy fire truck in making the main direct attack on forest fires encountered in this locality, with the exception of those on wire-grass flats. Its power, maneuverability, and water capacity make it the most satisfactory all-round heavy-duty fire truck tested. It is capable of traveling over roads and cross-country with a full load, except in flats where the muck is so soft that it will not support the weight.

A similar installation on an identical chassis was made, using a Yale-Towne fuel-transfer pump, operated by a power take-off. This unit gave substantially the same operating efficiency as the preceding unit, the essential difference being the pump. Since the Yale-Towne pump was designed for large volume discharge at low pressure, this pump refills the tank from natural sources more rapidly than the Panama pump, as two discharge hoses are used simultaneously.

One of the trucks converted was equipped with a winch mounted in front of the radiator, operated by a power take-off. This has proved very effective in enabling the truck to pull itself or other trucks out of sand or mud. This is a desirable feature for a forest-fire truck.

NUMBER 325 BRUSH TRUCK

An early model of the No. 325 "brush truck" furnished by the Corps of Engineers was tested. This unit was a $1\frac{1}{2}$-ton Ford 4×2 (2-DT) on which a Champion rotary 300-gpm pump, driven from the forward end of the crankshaft, was mounted. The welded-steel tank and other equipment were mounted on the chassis.

The thick scrub-oak brush of this area made it impractical to take this truck off roads in fire fighting. The pump is so located that it is very easily damaged by the brush. Numerous valves, water lines, and cutoff control rods are mounted in exposed positions and these would be damaged to such an extent that the equipment could not function. The rear platform extends far behind the rear wheels and in crossing rough places it drags. The tank holds only 360 gal of water and the two discharge hoses with $\frac{1}{4}$-in. nozzles make this water supply inadequate for direct attack on fire lines, where a small stream of water is needed which will last for a long period of time. As the truck has only two driving wheels, it is impractical to use it in many sandy places which can be traveled by all-wheel-drive trucks.

By recognizing the limitations of this truck and putting it to the uses to which it is best adapted, very effective work has been done. It has been used to refill trucks at fires to avoid lost time of these vehicles in going for water. The pump has a large discharge volume and can refill trucks from its own tank or a natural source. It has been used as a stand-by on bombing ranges to put out target fires so the targets can be used for additional missions. When it becomes necessary to back fire against the main fire, the brush truck has been used to prevent breakovers from the back fires. This truck cannot be expected to replace the trucks which are used on fire lines, but its use as a refilling unit makes it possible to increase the effectiveness of any trucks available.

A new model of the No. 325 brush truck with similar equipment, mounted on a $1\frac{1}{2}$-ton Chevrolet 4×4 chassis is being tested. The pump is mounted higher than on the older model and less equipment is in exposed positions. The rear platform has been removed and exposed equipment is being removed or being protected by guards. By using smaller nozzle tips, the water supply can be conserved and as the chassis is the same as the $1\frac{1}{2}$-ton trucks previously described, its performance should be comparable. The tank capacity being less should enable this unit to travel on softer ground. This unit is now in the process of extensive tests and final results are not known.

THREE-QUARTER-TON DODGE WEAPON CARRIER

An Ordnance $\frac{3}{4}$-ton Dodge weapon carrier was converted to a forest-fire-fighting truck by removing tarpaulin, bows, and seat frame and installing a 200-gal water tank and a Panama fan-belt-driven pump. A metal cab was installed, made of welded tubular steel covered with galvanized sheet iron. Difficulty was experienced in mounting the Panama pump because of the location of the top water-hose connection and generator. This was overcome by making an offset adapter for the base of the pump by bolting two pieces of 2-in. angle iron together, one of which was drilled for the cylinder-head bolts and the other was drilled to match the holes in the base of the pump. This set the pump out 2 in. from the cylinder-head bolts and down 2 in. below the level of the top of the cylinder head and gave adequate clearance between the pump pulley and the radiator hose.

This vehicle handles better than the $\frac{1}{2}$-ton pickup and its very short wheel base makes it highly maneuverable in the woods. It has ample power, and its large tires (9.00-16) and four-wheel drive give it better traction and more road clearance than the $\frac{1}{2}$-ton pickup. It is able to travel in more swampy conditions than can either the $\frac{1}{2}$-ton or $1\frac{1}{2}$-ton trucks. While the truck has been used in primary attack, it has less water capacity than the $1\frac{1}{2}$-ton truck and is better suited as a secondary truck, following a truck of larger capacity. During periods when the fire weather is not extremely bad, this truck can replace a $1\frac{1}{2}$-ton truck. It is the best all-purpose "light" truck tested. Tests demonstrated that 200 gal is the largest volume of water that can be mounted on this type vehicle without excessive overloading. With this volume, two extra spring leaves had to be inserted in each of the rear springs. The improvised cab without glass makes it less desirable for the driver because of exposure to heat and smoke, but being open allows the hose man to operate the hose from the seat. It is not well adapted to the installation of radio because it lacks sufficient protection for the equipment from weather.

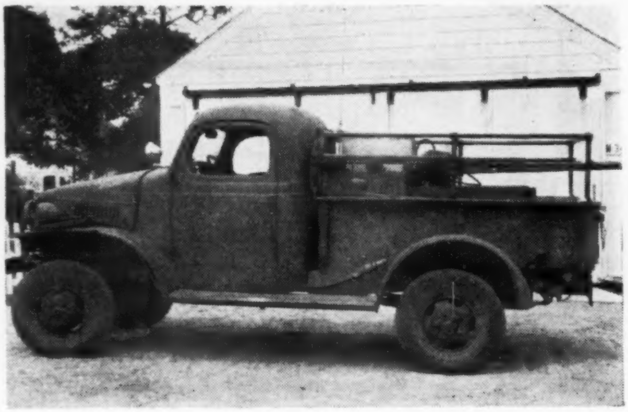
ONE-HALF-TON DODGE PICKUP

The standard Ordnance $\frac{1}{2}$-ton 4×4 Dodge pickup with metal cab made a desirable substitute for the original $\frac{1}{2}$-ton pickups. Tarpaulin, bows, and seat frames were removed from the truck and the equipment was transferred from the two-wheel drive pickup with only minor modifications. It performed as well as the original $\frac{1}{2}$-ton pickup truck, and the larger tires (7.50-16) and four-wheel drive enabled it to operate on terrain on which the 4×2 truck could not travel. The rugged construction reduced the damage to the vehicle to a minimum when traveling through heavy brush. This truck handled its load so well that larger tanks were installed with satisfactory results. Although the original tanks had a capacity of only 120 gal, 175- and 200-gal tanks were tested. The rated capacity of the vehicle was exceeded, but it was found that good performance could be obtained when a 175-gal tank made of $\frac{3}{32}$-in. sheet iron was installed. The 200-gal tanks made of heavier material were found to be impractical.

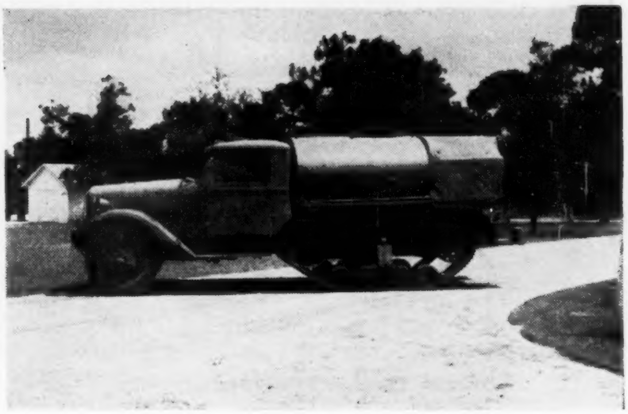
This vehicle is primarily used for forest patrolling and as a secondary truck. It is well adapted to use with radio, and the effectiveness as a patrol truck is greatly increased by installation of a two-way FM radio to keep the dispatcher informed as to the progress of fires and in reporting unusual conditions encountered.

The small water supply limits its effectiveness in furnishing the main direct attack on large fires without support. Its best use in fire fighting has been that of a secondary unit to follow the larger trucks to prevent breakovers or handle small fires which blaze up after the larger trucks have passed. Using the pickup as a secondary truck reduced the number of men required for patrolling and mopping up fires once controlled.

This truck does not have quite the maneuverability or speed of the two-wheel-drive pickup. As the truck gets older the steering becomes stiffer and there is more front-wheel vibration, causing greater wear on the front tires. Operating these vehicles on sand roads necessitates frequent replacement of uni-

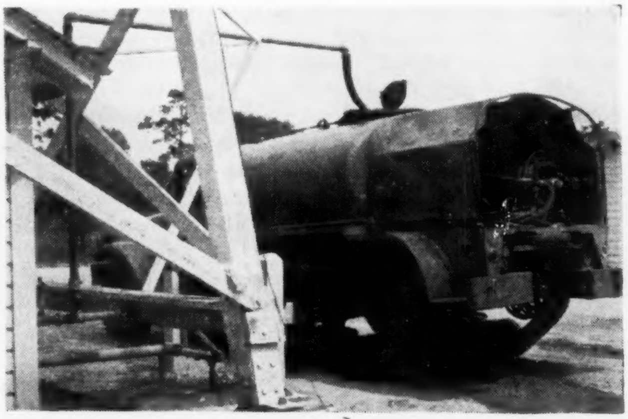


DODGE $^1/_2$-TON PICKUP TRUCK
(Equipped with 120-gal tank, radio installation, hand tools, and discharge hose mounted on left front fender.)



HALF-TRACK FOR USE WHERE GROUND IS NOT SUFFICIENTLY FIRM FOR WHEELED VEHICLES

CHEVROLET $1^1/_2$-TON CARGO TRUCK, SHOWING 500-GAL TANK AND DISCHARGE HOSE FROM PANAMA PUMP ON LEFT FRONT FENDER
(Short hose reduces pressure loss and is adequate for ordinary use; 50 ft of extra hose is carried in truck.)

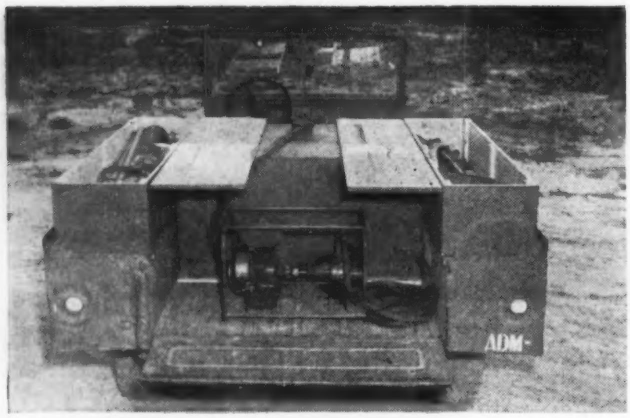


TANK AND REAR PLATFORM OF HALF-TRACK, SHOWING LIVE REEL AND SHORT HOSE FOR USE FROM DECK
(Suction hose and $1^1/_2$-in. hose mounted under platform. Yale-Towne pumps and Wisconsin motor are mounted on platform next to tank.)

NUMBER 325 BRUSH TRUCK ON FORD $1^1/_2$-TON CHASSIS AS FURNISHED BY THE CORPS OF ENGINEERS

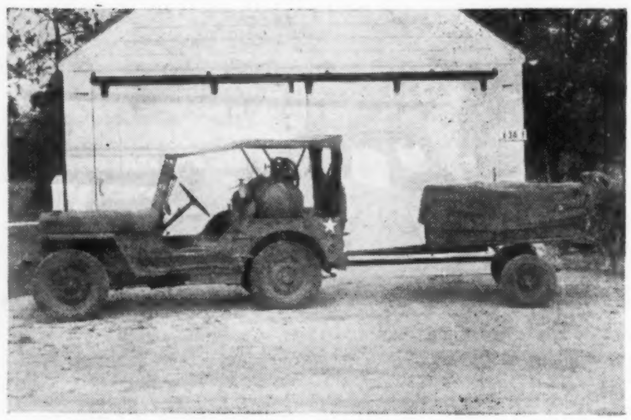
versal joints, particularly on the front drive shafts. The hydraulic-brake tubes are exposed and are frequently damaged in cross-country operation. The truck makes a satisfactory all-round patrol truck, but is underpowered for the job it is performing. The $^3/_4$-ton weapon carrier would be a much more satisfactory patrol truck if it had an enclosed cab.

Since the tank capacity is limited, experiments were made with smaller nozzle openings to conserve water. With the 0.25-in. tip, the 120-gal tanks lasted only 7 to 10 min, which is not sufficient time to corral even small fires. It was found that good streams of water were furnished with a properly designed tip having an opening of only 0.14 in. With this tip, the water supply lasted more than twice as long and was practically as effective in stopping fires, since increased pressure, created by the reduction of the size of the tip, caused the water to be broken down into finer droplets, approaching fog, which gives more efficient utilization of the water. The small tips so increased the effectiveness of the water supply on the pickup trucks that



DODGE $^3/_4$-TON WEAPON CARRIER

(View taken before installation of cab and Panama pump. Toolboxes replaced seat frames. The pumping unit is a type A-6 fuel-transfer unit, used as an auxiliary fire pump.)



JEEP AND $^1/_4$-TON JEEP TRAILER IN WHICH PACIFIC MARINE PUMPER, 1000 FT $1^1/_2$-IN. HOSE, AND ACCESSORIES ARE MOUNTED

THE 750-GALLON FOUR-WHEEL TRAILER TANK DRAWN BY $1^1/_2$-TON TRUCK

INTERNATIONAL T-6 TRACTOR AND BULLDOZER LOADED ON $2^1/_2$ G.M.C. CARGO TRUCK, TRAILING MATHIS TWO-DISK FIRE-LINE PLOW

they were equipped only with that size tip. The same conservation of water was applied to the larger trucks by equipping each with two tips, the 0.14-in. tip being used on all fires except at the heads of large fires and during conditions which made small tips inadequate.

QUARTER-TON RECONNAISSANCE (JEEP)

The vehicle tested was a standard $^1/_4$-ton, 4 × 4 Willys reconnaissance (jeep), equipped with 6.00-16 tires. In converting the jeep to a light fire-fighting and patrol vehicle, a 40-gal pressure tank, salvaged from a soda-acid fire extinguisher, was mounted horizontally immediately behind the front seats. This location was selected so that the weight would be as far forward as possible to distribute the load. On this tank, a tire-tube valve was installed so that air pressure could be applied to force the water out. In addition, a 15-lb carbon-dioxide (CO_2) cylinder was installed so that the pressure could be maintained as the water was forced out. A valve is located to control the flow of water to a 50-ft $^3/_4$-in. hose. The nozzle was reduced to $^1/_{16}$-in. opening. A pressure gage and pressure-relief valve were installed for safety. The tank can be refilled through the refill opening or by use of vacuum. A vacuum line was run to the intake manifold of the engine, using $^1/_4$-in. gasoline-type fittings with $^1/_4$-in. copper tubing. A control valve was mounted on the tank and the bleeder valve was installed to trap moisture which can be drawn off as necessary. When the vacuum refiller is used, the discharge hose becomes the suction hose.

Thirty-five gallons of water is the amount ordinarily used, allowing approximately a 5-gal capacity for head space. Pressure at 75 lb is ordinarily kept on the tank, being put in by any air hose or hand pump. As this will not discharge all of the water, the pressure is maintained by periodically opening the valve slightly on the CO_2 cylinder until the operating pressure of approximately 40 lb is reached. The use of compressed air to build up the original pressure reduces the amount of carbon dioxide needed. Fifteen pounds of carbon dioxide will discharge the tank five times. With a nozzle having a $^1/_{16}$-in. opening at an average of 40 lb pressure, the water supply will last 40 min and will produce a thin stream of water which can be sprayed 35 ft. By using the motor vacuum and the hose without a nozzle, the water can be replaced in the tank by vacuum in approximately 4 minutes under normal conditions.

The jeep has been used for all types of patrol activities and is especially good at reaching inaccessible places on the reservation. Its most spectacular use has been as a reconnaissance car for a fire "boss" on large fires from which he can watch the operations on fires and can make necessary reconnaissance to determine the action to be taken. With its water tank, it is especially useful in this capacity as it can be used to put out any breakovers that may be encountered by the fire "boss" while on reconnaissance. It is very effective in combating lightning fires as it can reach almost any place, and the amount of water carried is sufficient to handle small fires under normal conditions. It can operate on softer ground than any other vehicle tested. The jeep can pull the 1-ton cargo (tool) trailer or the 1-ton 250-gal water trailer, but these are ordinarily pulled by $^1/_2$-ton or larger trucks. It is the ideal vehicle for pulling the jeep trailer carrying the Pacific Marine Pumper. The only difficulty encountered in operating the jeep in thick scrub-oak

woods is the damage to the top. However, rips which usually occur near the bows can be easily repaired by a shop equipped to handle canvas.

TRAILERS

The large acreage of land under protection made it desirable to motorize all fire-fighting equipment possible. In order to make fire tools and special equipment readily available for dispatch, use was made of available Army-type trailers. All of the trucks are equipped with trailer hitches, so towing presented no problem.

The Nash-Kelvinator 1-ton two-wheel cargo trailer made an excellent portable fire-tool box. Three of these units were equipped and located at strategic places for most efficient use. Each of these was equipped with a complete assortment of hand tools for 50 men. All tools have distinctive markings so they can be replaced on the proper vehicle after use. These kits have saved much lost time in handling tools, and immediately after fires, they are made ready for future use. The tarpaulin and toolboxes on the trailers protect them from damage or weather. The 50-man kit consists of the following tools:

10 Rakes, asphalt	4 Pumps, back pack
10 Hoes, council	4 Lanterns, kerosene
15 Shovels	1 Burner, (back-fire torch)
2 Saws, cross-cut	1 Pair snaking tongs
4 Axes	

The 1-ton, 250-gal Lavine two-wheel water trailer has been used without change as an auxiliary water supply to refill fire trucks and furnish drinking water to fire-fighting crews. In cases where fire fighting was on open land or where buildings or targets were protected, these trailers have carried an auxiliary water supply directly to the fire behind pickups and, when the tank supply of the pickup was exhausted, the water was pumped from the trailer directly onto the fire by use of a long suction hose from the pump to the trailer.

The 750-gal four-wheel trailer tank is used as an auxiliary water supply on large fires and to furnish water for the Pacific Marine Pumper when it is operated away from a natural water supply. Use has been made in refilling fire trucks at fires, where the water is pumped from the trailer into the truck by either a No. 325 engineer brush truck, by the Pacific Marine Pumper, or by type A-6 fuel-transfer unit. This trailer has been used, towed by a $1^1/_2$-ton cargo truck, in protection of buildings or targets, by installing the Pacific Marine Pumper in the bed of a $1^1/_2$-ton cargo truck and pumping water from the trailer.

A type A-6 fuel-transfer unit has been mounted directly on this trailer to increase its efficiency in refilling trucks. The transfer unit has a large volume discharge, which enables it to pump considerably more water than the pumps on most of the trucks.

The $^1/_4$-ton jeep trailer, which was originally designed as an experimental trailer for use with the $^1/_4$-ton reconnaissance car (jeep), has been adapted to use as a carrier for the Pacific Marine Pumper, its fittings, and hose. The sides and gates were made of plywood and the containers for the pumper and 1000 ft of hose can be removed from the trailer. Wooden cleats were fastened to the floor of the trailer to hold each box in place. A cover was made for the entire trailer and its cargo and no other adaptations were necessary.

MOBILE FIRE-LINE PLOW UNIT

The Mathis two-disk fire-line plow is the best tested for this area. This plow used with the International tractor, T-6 or T-9 makes a very efficient unit for fire-prevention and fire-suppression work. On fire-prevention work, the T-9 tractor is more desirable as it has more power and wider tracks which enables it to plow lines faster and farther into the edges of the swamps and on more marshy lands. The T-6 proved to be a more desirable tractor for use with the Mathis plow in fire-suppression work. This tractor can be transported on a $2^1/_2$-ton truck, which carries skids and trails the Mathis plow which is mounted on pneumatic tires. On suppression work the plow can be disconnected, the tractor unloaded and rehitched to the plow and ready for use in 7 minutes.

On fire suppression, this plow has been most effective when following one of the larger water trucks to plow a line around the fire at the edge of the burned area. This greatly reduces the number of men required for patrol and mop-up. The plow is also used to prepare lines from which back fire can be started safely and to reach places which are inaccessible to the trucks. In wire grass it is often possible to stop fires with a plowed line, in places where it is not always possible to operate trucks.

RADIO EQUIPMENT

Five frequency-modulation, mobile, two-way radio units have been mounted on patrol pickup trucks. A stationary two-way radio is mounted at the Forestry Section Office, and it is used to maintain communications with the patrol trucks. The use of radio in patrolling and particularly on forest fires has greatly facilitated the dispatching of fire crews and has led to better use of the limited manpower available.

Table 1 outlines the specifications for various types of equipment tested.

TABLE 1 COMPARISON OF SPECIFICATIONS OF EQUIPMENT TESTED

	Autocar half-track	$1^1/_2$-Ton cargo truck	$1^1/_2$-Ton brush truck	$^3/_4$-Ton weapon carrier	$^1/_2$-Ton pickup	$^1/_4$-Ton jeep
Capacity	Special unit	$1^1/_2$ ton	$1^1/_2$ ton	$^3/_4$ ton	$^1/_2$ ton	$^1/_4$ ton
Driving wheels	Half-track and front drive	4 × 4 (2-DT)	4 × 2 (2-DT)	4 × 4	4 × 4	4 × 4
Tire size	8.25-20	7.50-20	7.00-20	9.00-16	7.50-16	6.00-16
Make	Autocar	Chevrolet	Ford	Dodge	Dodge	Willys
Pump	Yale-Towne	Panama and Yale-Towne	Champion 300-gpm	Panama	Panama	Compressed
Tank capacity, gal	750	500	360	200	120–175	40
Hose, discharge, in.	1	$^3/_4$	1	$^3/_4$	$^3/_4$	$^3/_4$
Hose, suction, in.	2	1	3	1	1	$^3/_4$
Nozzle tip, in.	0.25 and 0.16	0.20 and 0.14	0.25	0.14	0.14	0.07
Motor cooling	Standard	Standard plus $^1/_4$-in. line to pump	Standard plus built-in cooler	Standard	Standard	Standard
Hand tools:						
Back pump	0	1	2	0	4	0
Rake asphalt	0	5	0	0	2	0
Council hoe	0	2	0	8	5	2
Shovel	0	4	1	4	4	1
Axe	0	1	1	1	1	1
Flaps	0	0	0	5	2	0
Bush hook	0	0	0	1	1	0

FUEL-FIRED TECHNIQUES
and Their POSSIBILITIES

Part of a Symposium on "High-Speed Heating"

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As a preface to the subject of fuel-fired techniques for high-speed heating, it is necessary to mention that our experience has been with gas firing, and so the comments in the paper will be restricted to gas firing only. Another point which needs clarification is, "just what is meant by high-speed heating?"

If the heat source is combustion of fuel, heat must obviously be transferred to the object through the skin—from the outside in, if the object is solid; or from the inside out, or both, if the object is hollow.

HIGH-SPEED HEATING

For purposes of this discussion let us define "high-speed heating" as a heating rate at which we approach the heat-absorption capacity of the workpiece by approaching destruction of its surface, while the underlying portions are considerably below the temperature range at which destruction takes place. Obviously, the maximum heating rate for any solid is reached when the surface is destroyed, or materially changed from the desired structure; for example, if metal which is to be heat-treated melts on the surface, if magnesium ignites, or a firebrick or an insulating brick fuses on the surface.

It is also apparent that theoretically all fuel-fired heating, whether fast or slow, involves temperature differentials between the outside and the inside of the object during the heating-up cycle; in other words, "nonuniform heating." Further, such nonuniformities are greater with the faster heating speeds. Offhand this sounds rather bad, and not at all desirable in industrial practice. But let us see whether, in this instance, we are once again being deceived by "theory" and "sound."

HEATING NONFERROUS METALS

Fig. 1 illustrates a heating curve for a cupronickel billet. The upper curve represents the temperature of a thermocouple located $^1/_4$ in. below the surface. The lower curve is the temperature of the thermocouple located in the geometric center of the billet. Both couples are of course in the same horizontal plane.

The billet was heated in a vertical position with the heat being applied on the cylindrical surface only and not on the ends. It will be noted that, after 12 min of exposure to the heating source, a temperature of 1400 F is shown on the surface couple, and that in less than 1 min after the fuel was turned off the center couple and the surface couple show almost identical temperatures, even though an appreciable difference (decreasing from 300 F in the early stages of heating to 200 F in the later stages) existed between surface and center during the heating-up period.

Fig. 2 represents an identically dimensioned billet of brass, heated in identically the same manner, with identical fuel consumption, in the identical equipment. Since both charts are to the same scale, it is apparent that considerably less differential existed between the center couple and the surface couple during the entire heating period, and that a similar length of time elapsed after the fuel was shut off until the center and the surface couple showed the same temperature. Attention is again called to the fact that, after 12 min heating time, the surface couple showed a temperature of 1400 F.

Fig. 3 gives the heating curves for a copper billet of iden-

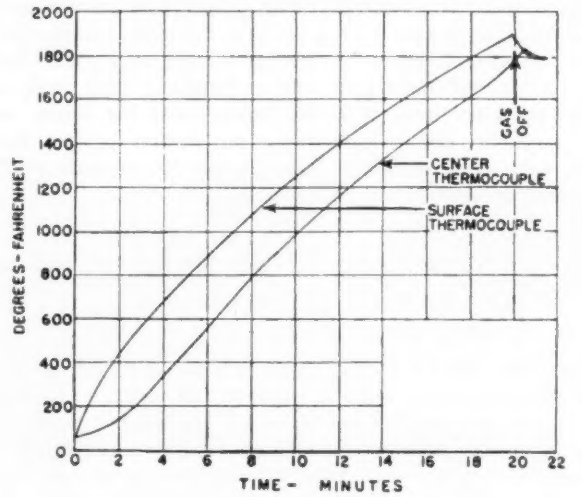

FIG. 1 HEATING CURVE FOR CUPRO-NICKEL BILLET
(Billet size, $7^3/_4$ in. diam × 15 in. long, weight 218 lb; gas combustion rate, 1200 cfh; combustion air rate, 5400 cfh.)

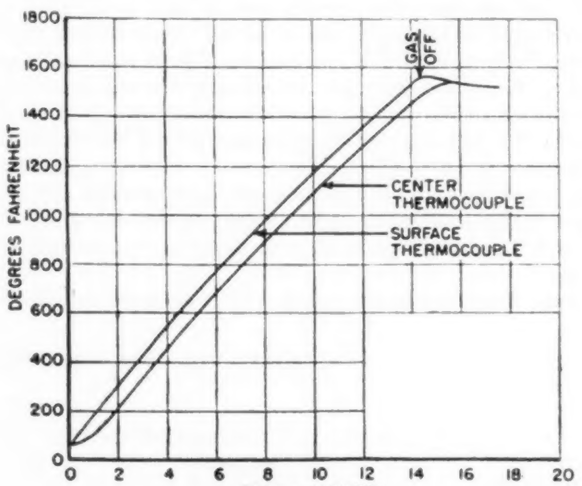

FIG. 2 HEATING CURVE FOR BRASS BILLET
(Billet size, 8 in. diam × 15 in. long; gas combustion rate, 1200 cfh; combustion air rate, 5400 cfh.)

Contributed by the Committee on Industrial Furnaces and Kilns of the Heat Transfer Division and presented at the Annual Meeting, New York, N. Y., Nov. 27-Dec. 1, 1944, of The American Society of Mechanical Engineers.

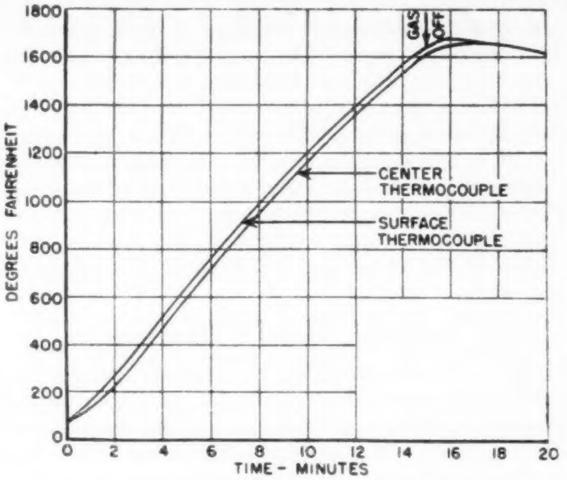

FIG. 3 HEATING CURVE FOR COPPER BILLET

(Billet size, 8 in. diam × 15 in. long; gas combustion rate, 1200 cfh; combustion air rate, 5400 cfh.)

tical dimensions, and heated under identical conditions. The temperature differential between surface and center is further reduced, but again, after 12 min have elapsed, the surface couple shows 1400 F temperature.

These three charts furnish an interesting confirmation of the different conductivities for the three different metals. The higher the conductivity, the lower the temperature differential, as can be expected. These three charts, however, permit further conclusions, namely, the lower the conductivity of the metal, the faster the rate of surface-temperature increase at the early stages of the heating process. Furthermore, with the heating rates applied in these instances, it is difficult to produce a temperature differential between surface and center of any practical significance.

In actual industrial practice, in so far as these three particular metals are concerned, the nonuniformity of temperature through the cross sections of the billets at gas shutoff or removal from the furnace is of little consequence, because of the handling time between heating and actual working, or because of the contact with cool handling fixtures, for example, an extrusion die which easily offsets higher surface temperatures.

However, the shorter heating time, which is shown in these curves, is materially less than is now conventional in industry, signifying shorter furnaces, less work in process, and, metallurgically, less oxidation or scale.

If we transfer these heating rates into smaller objects, the temperature differentials become even more insignificant. Thin strips of copper or brass, heated at such rates, will obviously not show a temperature differential even measurable in fractions of degrees, certainly not in so far as metallurgical effects are concerned. Bar stock or slugs tested up to 1 in. diam show uniform grain structure throughout after such rapid heating cycles as 30 sec from cold to full temperature for 1-in-diam bronze bars.

In so far as nonferrous metals are concerned, high-speed heating lends itself to and promotes continuous heat-treatment rather than batch operation.

EFFECT OF HEATING ON STEEL

Fig. 4 illustrates the heating curve for an S.A.E. 1095 steel billet $2^1/_4$ in. square, again heated only from the outside surface and not from the ends. The rapidity of heat transfer becomes evident by noting that the total time required to bring this billet to 2300 F was approximately 288 sec, or at a rate of 2.4 min per in. of thickness.

Fig. 5 illustrates the heating curves for an S.A.E. 4340 steel billet $5^1/_2$ in. square. A center curve has been added, showing the temperature at a point between the surface couple and the center couple. In this case, the heating rate is equivalent to 3.64 min per in. of thickness.

Both these curves clearly show that under our measuring conditions with a millivoltmeter at 10-sec intervals, the surface couple did not indicate the thermal critical point, while the interior points of the billets clearly indicated the thermal critical point. Whether this is due to instrumentation or to

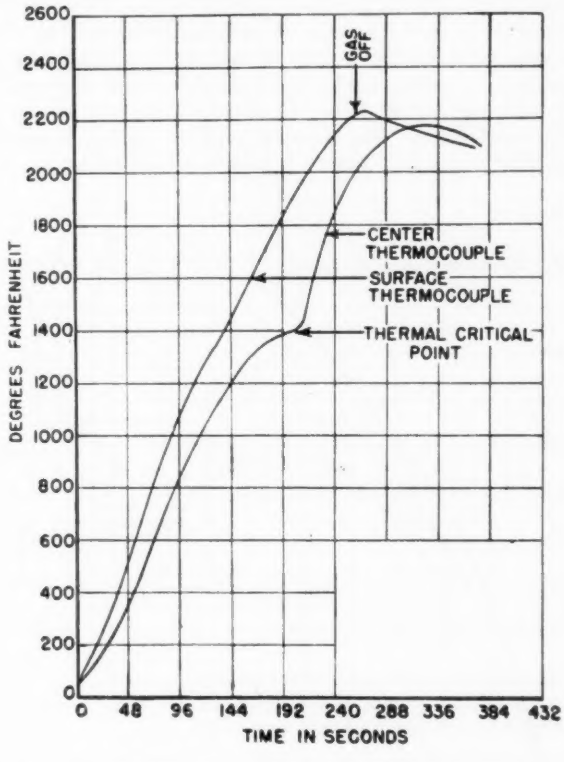

FIG. 4 HEATING CURVE FOR S.A.E. 1095 STEEL BILLET

(Billet size, $2^1/_4 \times 2^1/_4 \times 3$ in.; gas combustion rate, 560 cfh; combustion air rate 2600 cfh.)

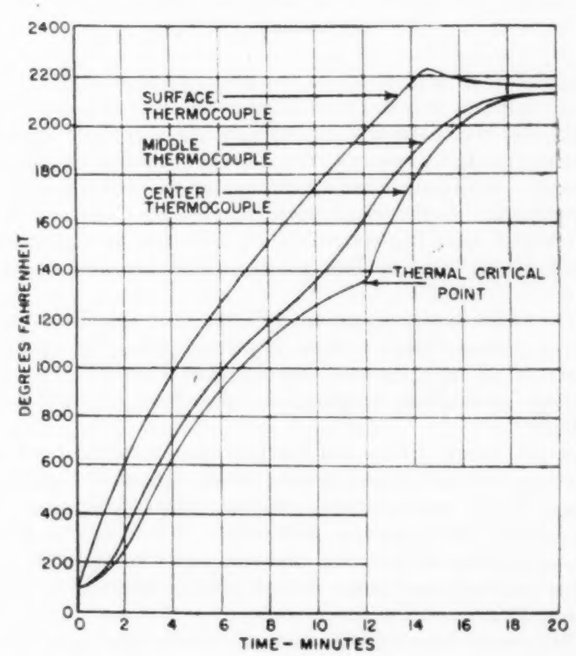

FIG. 5 HEATING CURVES FOR S.A.E. 4340 ALLOY-STEEL BILLET

(Billet size, $5^1/_2 \times 5^1/_2 \times 10$ in.; gas combustion rate, 1200 cfh; combustion air rate, 5400 cfh.)

the fact that the heat-absorption capacity of the surface is so great that the thermal critical interval disappears, while in the center the slower heating rate makes it measurable, has not as yet been determined. Nevertheless, the slower heating rate is responsible for the center readings.

The billets exposed to these heating cycles were carefully checked for internal cracking, and no evidence could be found. The surface was studied, and the extent of decarburization determined at approximately 0.001 in.; the extent of surface scale at approximately 0.001 to 0.002 in.

Compared with the previous heating curves shown, it is apparent that in steel a greater temperature differential exists between surface and center, but at such heating rates even this differential is substantially minimized for thin sections, and such sections can therefore be rapidly heat-treated without detrimental effects. For example, steel tubing can be annealed with this technique, and even stainless-steel tubing is being

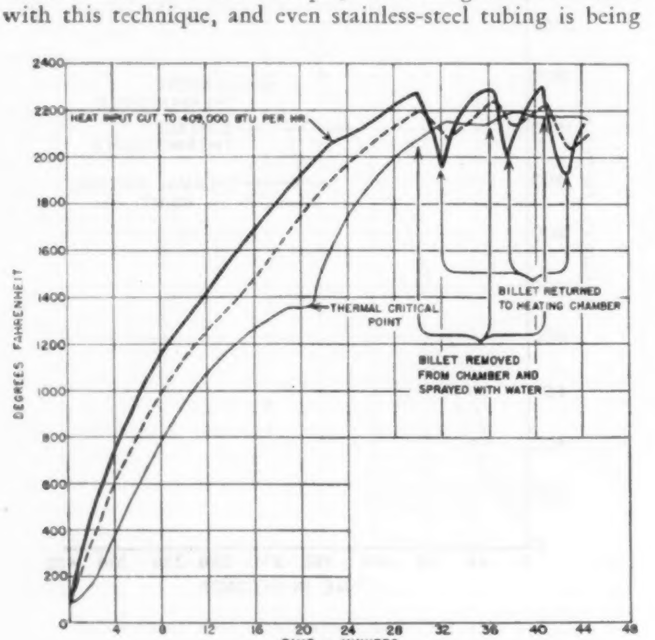

FIG. 6 HEAT-CHILL-REHEAT CURVES FOR S.A.E. 1095 STEEL BILLET
(Billet size, 8 in. diam × 12 in. long; gas-combustion rate, 1800 cfh; combustion air rate, 8050 cfh.)

annealed with a total furnace exposure time of 10 sec. Strip heat-treatment becomes a practical possibility on a continuous basis, and one of the first applications has been to the fusion of electrolytically deposited tin in the continuous tin-strip process. In this instance, a heating section 6 ft long raises the temperature of the electrolytic tin and the steel sheet to 525 F and fuses the tin to the steel surface, at a production speed of 600 fpm, or during a total exposure time of 0.6 to 1 sec.

The problem of temperature differential or nonuniformity on heavy sections plays a more important role, but again the question of time between heating and processing, such as rolling, fabricating, forging, or quenching, must be considered.

In any event, differential heating permits surface-hardening of steels, and this process is now being successfully applied to gears, shafts, tank grousers, railroad rails, bearing races, and even larger objects such as mill rolls. In fact objects weighing as much as 25 tons are now being surface-hardened. Another practical application is localized heat-treatment, including gradual transition zones.

Differential heating, which in some instances might be undesirable, therefore affords us also new opportunities of heat-treatment which were heretofore not available and which have not as yet been fully exploited.

Other possibilities of high-speed heating might also lie in the reheating of billets during processing. A blooming-mill billet cools on the surface partially by contact with air and radiation, but also by contact with cold handling equipment.

Fig. 6 illustrates a series of tests conducted for the purpose of determining the time required to restore 200 F temperature in the surface of an 8-in-square steel billet. In these laboratory tests the surface was cooled by water spray, and subsequently the billet was reinserted in the hot furnace. Even though the surface-cooling effect clearly extended to the thermocouple $1^1/_4$ in. below the billet surface, 200 F could be restored in the surface within 1 min.

NEW DEVELOPMENTS IN COMBUSTION

To obtain these heating rates just reported, the gas-combustion process had to be accelerated, and the temperature of the heating medium had to be raised beyond the temperature commonly employed. The aim to produce these effects brought about two new basic combustion developments, both being based on the use of ceramic materials. Incandescence in the one case is utilized for radiation to the work, and in the other to accelerate the combustion process. Essentially both these heating elements are complete combustion chambers, and the heating effects produced are controllable and allow also for heat distribution and pattern heating.

Ceramics play an important part in this technique of high-speed heating with gas. The higher temperatures involved are clearly beyond the temperature resistance of any known metal. We will not be able to decide here the scientific controversy whether ceramics have a true or simply an apparent catalytic effect upon the combustion process, but we do state categorically that ceramics are being deliberately and effectively used to produce the results just reported.

CONCLUSION

It must be clear from these brief remarks that the gas technique of high-speed heating is in the pioneer phase. In no instance have we reached the maximum heating rates, clearly not for high-conductivity metals, such as copper and brass. Investigations are incomplete and considerable additional research and development work in the laboratory and in the field will be necessary. In fact, it is apparent from the foregoing that our early definition of high-speed heating is inadequate.

Research data will eventually provide proper correlation between heat source, temperature, and conductivity. Possibly a formula may be devised for maximum heating rates, or shall we say for maximum absorption capacity under these gas-heating techniques. So far a few new heating tools have been produced which will be improved upon, and which undoubtedly will be followed by others. New possibilities in heating rate have been shown, and indications are undeniable that we require a new analysis of heating, metallurgical, and process requirements to find the proper field of usefulness for these techniques and to take full advantage of the potentialities and the effects.

The influences of conductivity require scrutiny, because different alloys will produce different temperature differentials, and therefore affect the rate of penetration. This rate of penetration in turn influences depth of hardness, for instance, and it may not be too farfetched to forecast that conductivity can enter into the selection of a steel for a certain product, in the same manner as carbon content, alloy additions, and cost.

Alloys are now added for ultimate effects, such as hardness, tensile strength, and quenching rates; why not also for heating rates, since they influence heat-treating results? What a pleasant thought for a heat-transfer division, and the specification and metallurgical engineers.

TIME-TEMPERATURE *Relationships* *in* WORKPIECES

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THIS report emphasizes working with extremely high temperatures and particularly skin temperatures up to 3000 F. In view of the fact that steel has a melting point of well below 3000 F, we have assumed that the temperature referred to is that of the furnace gases to which the charge is exposed. Even as furnace temperature, the value of 3000 F is extremely high and indicates possible danger of nonuniformity; therefore the following comments will be devoted to the question of uniformity in individual pieces. Conditions in stacks or piles of materials are more complicated, and while also amenable to rational analysis, will not be discussed here.

The purpose of heating material in furnaces is of course to obtain uniformly heat-treated material, where the term "heat-treated" is used in the broadest sense for any heating operation other than melting. The uniformity does not necessarily mean that all parts of the workpiece should reach the same temperature, because, in surface-hardening or in localized hardening, temperature differences are desired and are part of the necessary process. In all heating operations, however, it is desirable to know what uniformity actually is achieved; this report deals particularly with such processes where actual thermal uniformity is important.

In speaking of thermal uniformity, the following factors enter the situation:

1 Temperature differences at the end of the heating cycle.
2 Time of exposure to any given temperature.
3 Uniformity of rate of heating (degrees per unit time).

Theoretically it is impossible to satisfy the foregoing conditions of uniformity because heat transfer from the furnace to the piece or from the surface of the piece to its core can occur only if temperature differences exist which preclude the fulfillment of conditions 2 and 3. Generally speaking, the lower the temperature differences, the lower will be the output from a given furnace. The problem for the heat treater, then, is to find a workable compromise between the desire for uniformity, as defined by factors 1, 2, and 3, and the necessity of obtaining output. All three items mentioned are, generally, not sufficiently recognized. They will be treated hereafter separately.

TEMPERATURE UNIFORMITY WITHIN THE WORKPIECE

This uniformity is defined by the greatest temperature difference within the workpiece at the end of the heating cycle, independent of the rate of heating applied to the piece, and independent of how long any part of the piece has been maintained at an elevated temperature.

It can be shown that the greatest temperature difference within the piece determines definitely the heating time as well as the furnace temperature, provided the piece, when at cold uniform temperature, is placed in a furnace which maintains its constant temperature throughout the heating of the piece. This is of great importance and will be referred to again.

For the sake of convenience, this uniformity can be expressed by a dimensionless "uniformity factor" U which is defined a follows

$$U = \frac{\text{Surface temperature}) - (\text{core temperature})}{(\text{Surface temperature}) - (\text{ambient temperature})}$$

The advantage of using a dimensionless "uniformity factor," rather than expressing the uniformity as temperature difference in degrees, is to be seen in the possibility of developing general rules and curves. Such curves have been developed for certain simple shapes.

Before discussing the development and application of these curves some remarks on the uniformity factor may be in order. The definition of the uniformity factor is based on the "surface temperature." The simple shapes of a semi-infinite slab, an infinite cylinder, and a sphere have at any time during the heating process uniform surface temperatures, provided that they are exposed to uniform temperatures on all sides. In all other cases, even if they seem simple, like a cube, a parallelepipedon, a finite cylinder, etc., this condition is no longer fulfilled. For defining the uniformity factor in those cases, it is necessary to introduce the maximum surface temperature, which, e.g., in the case of a cube, occurs in the corners.

But, even for the foregoing simple shapes, the condition of exposure to uniform temperatures on all sides is frequently not fulfilled. For example, a plate placed on the bottom of the furnace does not heat uniformly even if the influence of the sides is not considered, and if the furnace has top and bottom heat. The heat transfer from the top will encounter a different resistance from that coming from the bottom, resulting in a different rate of heating from the two sides. However, for the sake of obtaining some numerical values, and because the rational analysis of the heating process yields some extremely interesting results, it will be assumed that such uniform heating is obtainable.

Complete curves showing furnace temperature and heating time for any material and any dimension of the three simple shapes mentioned have been developed and will be contained in a later paper. These curves are plotted in a manner similar to the well-known Gurney-Lurie (2)[1] charts, or Groeber-Schack (1), or their interesting modification by Bachmann (3). On the abscissa axis, dimensionless time is plotted; uniformity factors are shown as ordinates. The individual curves hold for different values of relative boundary conductance. By selecting a given uniformity factor, these curves allow reading of the necessary heating time. Applying this time then to one of the established Gurney-Lurie charts, the furnace temperature can be found.

Thus, the earlier statement that the uniformity factor is definitely tied in with the furnace temperature and the heating time is proved. If a certain uniformity factor is desired (or, in other words, if a given temperature difference between surface and center is required), then the furnace temperature and the heating time cannot be selected but follow definitely from the thermal properties of the piece and its dimensions. In using these curves, it should be kept in mind that they apply only

Contributed by the Committee on Industrial Furnaces and Kilns of the Heat Transfer Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

[1] Numbers in parentheses refer to Bibliography at end of the paper.

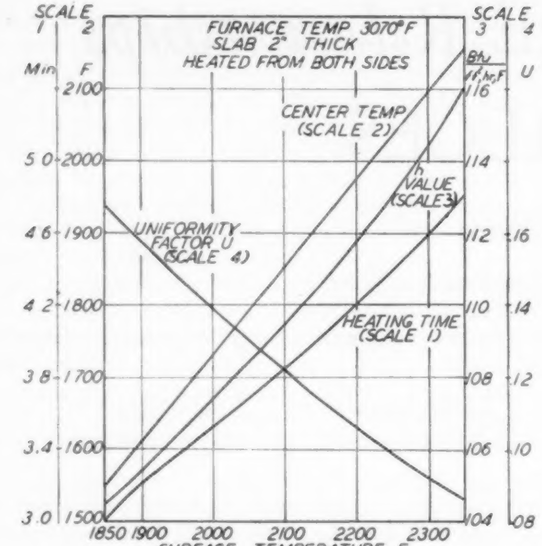

FIG. 1 CURVES OF HEATING TIME IN 2-IN-THICK STEEL SLAB HEATED FROM BOTH SIDES; FURNACE TEMPERATURE 3070 F

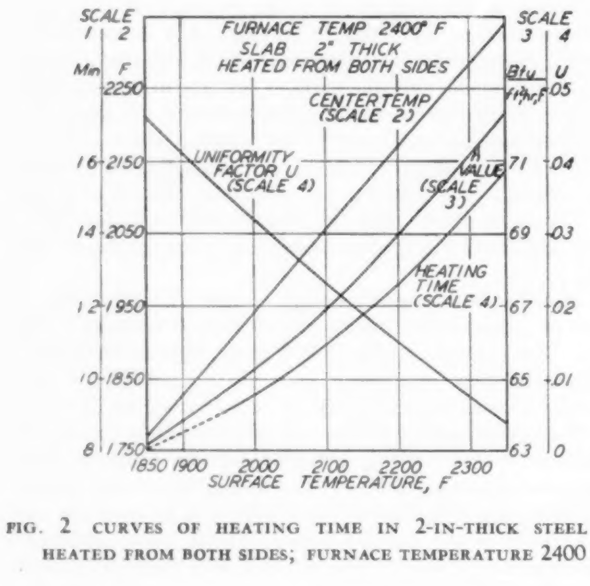

FIG. 2 CURVES OF HEATING TIME IN 2-IN-THICK STEEL SLAB HEATED FROM BOTH SIDES; FURNACE TEMPERATURE 2400 F

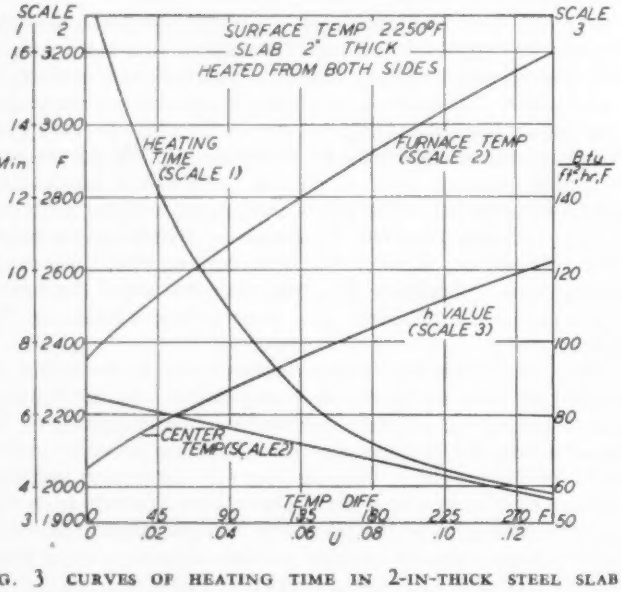

FIG. 3 CURVES OF HEATING TIME IN 2-IN-THICK STEEL SLAB HEATED FROM BOTH SIDES; FURNACE TEMPERATURE 2250 F

to individual pieces exposed on all sides to uniform temperature.

As an example of these curves, and in view of the special emphasis on high temperatures, Fig. 1 refers to the temperature uniformity and heating time in a steel slab 2 in. thick, heated from both sides in a furnace with a gas temperature of 3070 F. The furnace temperature of 3070 F instead of 3000 F was introduced by an oversight. Time did not permit repeating the work for 3000 F. (Thermal conductivity of the steel, k = 18.4 Btu per ft per deg F per hr; specific heat, C = 0.165 Btu per lb per deg F; density = 468 lb per cu ft.) It is assumed that the surface temperature is not to exceed 2350 F. The graph contains four curves, one showing heating time, the second temperature differences (uniformity factor), a third the center temperatures; a fourth curve shows the boundary conductance used in the computations; it is taken as the black-body radiation from a surface at 3070 F to one having $^1/_2$ of the surface temperature; emissivity is taken as 0.83. This procedure was considered to yield reasonable compensation for not introducing a convection component.

From Fig. 1, it appears that the temperature of 3070 F permits only very nonuniform heating. By way of comparison, Fig. 2 shows similar curves for a furnace temperature of 2400 F, and the same surface temperatures, and, finally, Fig. 3 shows the furnace temperature and heating time plotted against uniformity factor and temperature differences for a surface temperature of 2250 F.

Comparing the results of Figs. 1 and 2, some typical figures may be obtained. For example, if a surface temperature of 2000 F is to be reached, the heating time will be 3.69 min at a furnace temperature of 3070 F, but 9.1 min at a furnace temperature of 2400 F. This longer heating time results in considerably improved uniformity. The center temperatures are 1735 F for a furnace temperature of 3070 F and 1940 F for a furnace temperature of 2400 F.

One important conclusion from these charts can be drawn. Raising the furnace temperature, or, as the expression is generally used, forcing the furnace, means sacrificing temperature uniformity.

It has been suggested to expose pieces to a very high temperature for a short time and then drop the furnace temperature. Because of the infinite variety of possible combinations of preheat and final temperature, it has not as yet been possible to set up general curves, although it appears entirely feasible to develop curves which would have the following character:

Exposure to A per cent of the final surface temperature to be plotted for various lengths of "dimensionless time." The dimensionless time is used as is customary in heat-transfer calculations, namely, as the product of

$$\frac{\text{Thermal diffusivity} \times \text{Time}}{\text{Square of the thickness}}$$

Not having available such curves, an example was carried out on the Heat and Mass Flow Analyzer at Columbia University. This example is shown in Fig. 4. Again, a furnace temperature of 3070 F and a slab of 2 in. thickness having the same properties as before were assumed. This time the exposure was limited to only 3.76 min, at which time the surface temperature had reached a value of 2070 F. Then the furnace temperature was dropped to 2350 F and heating continued until a surface temperature of 2320 F was reached. The loss in time and gain in uniformity can be found by comparison with Fig. 1. With constant heating, Fig. 1, a surface temeratur of 2320 F is reached after 4.7 min; the center temperature is only 2120 F, the uniformity factor, U = 0.09. With rapid initial heating and later drop of temperature, Fig. 4, a surface temperature of 2320 F is reached only after 9.27 min (curve B); but the center temperature is 2290 F, the uniformity factor, U = 0.013.

Finally, for cases where the surface temperature need be held

only within a certain range, it has been suggested to heat the piece up quickly to a surface temperature equal to the upper permissible temperature limit and then cut the furnace temperature down. Fig. 5 shows the temperature-time history of such a procedure applied to the same 2-in. steel slab. The furnace temperature was 3070 F for 5.05 min; at that time, the surface had reached a temperature of 2350 F, which was considered to be the upper permissible limit of the surface temperature, the lower being 2250 F. Then the furnace temperature was dropped to 2350 F. After 0.27 min, a uniformity factor of 0.025 was reached, the difference between surface and center temperatures being (2260 — 2205) = 55 deg F. This procedure works out satisfactorily, if handled with sufficient care, and if the permissible differences between inside and outside are sufficiently great.

TIME OF EXPOSURE

The infinite variety of shapes makes it difficult to develop general curves concerning time of exposure. The following example is given to provide some idea of the differences in time which occur:

A very long square steel bar is being exposed to a constant furnace temperature of 3070 F on its four sides. The steel has the same properties as in the foregoing examples. In order that the surface temperature should not exceed 2350 F, the heating time must be limited to 2.82 min. The resulting uniformity factor is $U = 0.172$.

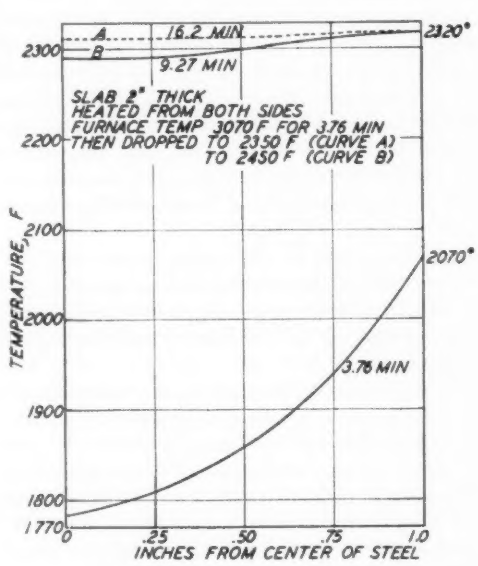

FIG. 4 CURVES OF HEATING TIME IN 2-IN-THICK STEEL SLAB AS DETERMINED BY HEAT AND MASS FLOW ANALYZER

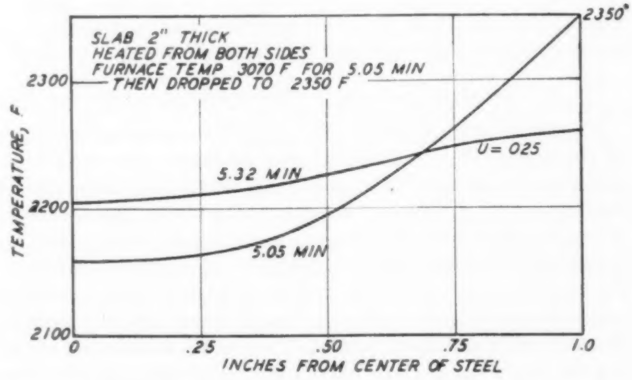

FIG. 5 TEMPERATURE-TIME HISTORY WHEN SLAB IS HEATED QUICKLY TO 3070 F AND THEN DROPPED TO 2350 F

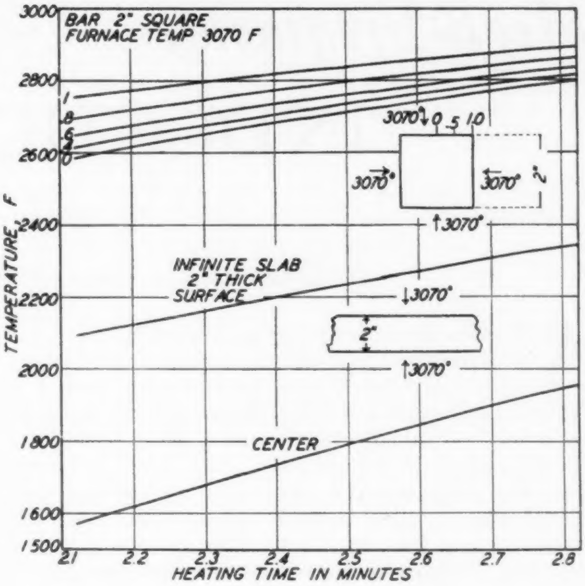

FIG. 6 HEATING CURVES FOR SQUARE STEEL BAR

Now, if the square bar is exposed, for the same length of time as the slab previously mentioned, to the same temperature, then, due to the corner effect and the large surface/volume ratio its temperatures will be very much higher; in fact the bar would melt. Fig. 6 shows the conditions. Not only would the temperatures be entirely too high, but also they would not be uniform over the surface. Curves 0, 0.2, etc., to 1 show the temperature rise of each of the four faces, 0 being the center and 1 being the edge.

Approximately the same relations hold if all temperatures (that of the furnace as well as those of the bar) are divided by the same amount, e.g., if one half the values are taken. Then, with a furnace temperature of 1535 F, the center of the face would be at 1400 F, whereas the edge would have reached a value of 1447 F.

It is important to note at this point that an improvement in heat transfer to the surface (boundary conductance) will make the differences between edge and center of the face larger.

Conditions are of course much worse in pieces of nonuniform cross section, say a cutting tool with thin edges. In order to evaluate such cases, as a first approximation it is possible to determine the heating time for the thickest section and then determine the temperature differences in the thinnest section, applying the same furnace temperature and heating time. This procedure amounts to neglecting, in the first approximation, the heat flow from the thin section to the thick section.

UNIFORMITY OF RATES

The rates of heating are quite different on the sides and in the center of any piece heated, following any normal procedure. Moreover, the rates change with time. It is practically impossible to obtain equal rates at thin and thick sections or at the surface and the center of a piece. Even a finite body with corners and edges cannot be heated at a uniform rate. The corners will always heat faster than the center of a side. It is possible in individual cases to determine the heating rates as a function of temperature at various points in the body.

It is desirable to study what differences in temperature, in time of exposure, and in rate of heating do occur, and then to have the metallurgist and ceramists give their specifications for desired rates to obtain certain qualities. Then the problem should return to the heat-transfer and furnace engineer, who, based upon the geometry of the pieces involved, on the arrangement of the pieces in the furnace, and the furnace design, should find out if these desired rates are obtainable.

(*Continued on page 452*)

High-Frequency INDUCTION HEATING

By WESLEY M. ROBERDS

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As a means for heating metals, high-frequency electrical induction is rapidly making a place for itself among the older and better known methods. It is not a world revolutionary process which will supplant all others but, rather, it is a new and valuable supplementary process which has its own particular field of application. This field includes heating jobs which either would be impossible or much more costly if attempted by any other method. Therefore induction heating should be regarded merely as a new heating technique. It is the purpose of this paper to show how induction heating compares in its various aspects with other more conventional methods.

In the general heating problem there is a "source" where electrical or chemical energy is converted into heat energy. This heat is then transferred to the work either by thermal conduction or radiation. (Here the term "work" is used, as in industry, to mean the piece to be heated, the object worked on.)

The rate at which energy is transferred from source to a unit area on the work—in other words the *power concentration*—is determined by many factors. Among these are: The power available in the source; the difference in temperatures of the work and of the source; the actual temperature of the work; the geometry of the heating setup; and other less important quantities.

Consider a few typical cases. In heating with a gas mixture the chief factors which limit the power concentration are the temperature, mass, and specific heat of the gas and the amount of hot gas which can be brought into contact with the work in unit time. Thus a well-designed torch, using an oxygen-acetylene mixture, will produce a power concentration of perhaps 500 Btu per min per sq in. of work surface. However, the area covered with a single torch is of course only a few hundredths of a square inch. The most advanced type of gas burners using a premixed combination of propane and air will cover extended areas at power concentrations of about one fifth the foregoing value.

RADIATION METHOD

Another heating method which has recently gained great popularity is that of infrared radiation heating. The simplest arrangement for high-power radiation heating is the inclosure of the work within a furnace whose walls are maintained at a high temperature. If it were possible to keep such a furnace at 3000 K (about 5700 F), the maximum rate at which a cold black body would receive radiant energy is about 170 Btu per min per sq in. It is theoretically possible to increase this rate somewhat by the use of complicated and bulky focusing arrangements instead of a furnace, but at present such methods are impractical. Moreover, any increases in power concentration would probably be gained at the expense of ability to heat large areas.

The chief limiting factor in radiation heating is the maximum temperature which it is possible to attain in a practical furnace. Other limiting quantities are the reflectivity of the work surface, power available, and bulk of the equipment.

Contributed by the Committee on Industrial Furnaces and Kilns of the Heat Transfer Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

Most gas furnaces combine flame heating and radiation heating. Recently some ceramic burners have been designed to make the most of this combination method. By their use it is possible to obtain power concentrations of 300 Btu per min over areas of a square inch or so.

HIGH-FREQUENCY INDUCTION HEATING

High-frequency induction heating was first used because of its great convenience and because by its use it is possible to heat metal parts sealed in a glass envelope. Recently however it has been found that induction heating will produce the highest possible power concentrations on certain classes of work. Moreover it lends itself to a nicety of control which far exceeds that of any other heating method.

This method differs fundamentally from other heating processes in that the energy which is transferred from source to work is not in the form of heat or radiation but rather is the alternating magnetic flux which is generated in the applicator coil and which links through the work to be heated. The heat is then generated within the work itself. If the work is a magnetic material and has a medium value of electrical conductivity (steel is almost ideal in these respects) the efficiency of energy transfer in induction heating is many times as great as if thermal energy were first generated in a source and then transferred to the work.

Induction heating can be used at low power concentrations to feed power into areas of several hundred square inches; or by going to radio frequencies and a single loop applicator coil, it is possible to put more than 5000 Btu per min into a single square inch of area.

Thus induction heating in general can be used as a furnace to heat large objects or as a torch to concentrate high powers in accurately controlled local areas. It should be pointed out, however, that just as some types of work require a furnace while others are best heated with a torch, so the same type of induction heating equipment is not adapted to all kinds of work. In general, the larger volumes should be heated at relatively low power concentrations by the use of multiturn applicator coils and low frequencies. On the other hand if the heat is to be highly localized and intense, radio frequencies and coils with a very few turns are necessary. Motor generator sets are satisfactory for generating low frequencies for the "furnace" type of heating while electronic generators are necessary to develop the radio frequencies for the "torch" type of application

LIMITING FACTORS IN INDUCTION HEATING

The chief limiting factors in induction heating are the shape of the work and the electrical and magnetic properties of its material. In general the type of piece best suited for induction heating is a steel cylinder. Certainly the work should be symmetrical. This is not to say, however, that odd shapes cannot be heated by induction, but it is difficult to heat them uniformly. For instance, gears are likely to heat to a much higher temperature at the tips of the teeth. It is with great difficulty that the bottoms and roots of the teeth can be heated without overheating the tips. On the other hand if it is desirable to heat only the projections such as the teeth of a saw blade, induction heating gives excellent results.

Therefore in distinguishing those applications which are best suited for induction heating from those which can best be done by other means the following general rule can usually be followed: Induction heating is best for jobs where nonuniformity of heating is desired; where high temperature gradients are to be established. Uniform heating can be obtained only where the shape is cylindrical and a progressive heating method can be used. (Even in this case uniformity of heating in depth must depend to a large extent on thermal conduction.)

Since size, shape, electrical properties, and frequency determine the results in induction heating let us consider first those quantities which affect the power concentration. These shall be characterized by the term "intensity factors." We shall then see how these same quantities also become "control factors" and work together to determine the extent and depth of volume in which heat generation takes place.

INTENSITY FACTORS

The transfer efficiency[1] can be shown to involve the quantity

$$\sqrt{\frac{\sigma_c \ \mu_w}{\sigma_w \ \mu_c}}$$

where σ_c is the electrical conductivity of the material of the inductor coil (generally water-cooled copper) and μ_c is the magnetic permeability of the coil which of course is unity if the coil is of copper. Similarly, σ_w and μ_w are, respectively, the electrical conductivity and magnetic permeability of the work material.

This efficiency also varies with the size of the inductor coil and its spacing from the work. Thus if the inductor is a round copper tube of radius a and is spaced with its center a distance h above an infinite plane, which constitutes the work, then the transfer efficiency can be written as

$$E = \frac{1}{1 + \frac{h}{a}\sqrt{\frac{\sigma_w}{\mu_w \sigma_c}}}$$

If the work is not an infinite plane but is shaped with corners, whose radii of curvature are not large compared to the spacing h, the efficiency is somewhat less than that given by the formula. If the work is a cylinder whose radius is several times as great as h then the foregoing formula is essentially correct.

As for the size of circuit components, the most important factor is the size and shape of the applicator itself. For example, if an inside surface is to be heated such as the bore of a tube and the applicator is, say, a one-turn loop of copper tubing the outside diameter of that tubing is important. The efficiency decreases rapidly as the outside diameter of the inductor tubing increases.

The frequency enters the problem only as a quantity of secondary importance, and its effect will be discussed after the concept of depth of current penetration has been introduced.

CONTROL FACTORS

High-frequency currents, because of inductance effects, tend to travel on the surfaces of conductors. In other words, the higher the frequency the greater is the tendency for the current to be "blocked out" of the inner parts of an isolated conductor, thus leaving the maximum current densities at the surface. Since the decrease of current density from the surface inward follows a logarithmic law, a useful concept for dealing with high-frequency phenomena is that of the "penetration unit." It is defined as the depth below the surface of a conductor at which the current is 1/e times its value on the surface. Here e is the base of the natural logarithms. Hence, at a depth of one penetration unit the current density is approximately 37 per cent of its value at the surface.

[1] Ratio: Power in the work to power delivered to applicator coil.

Another way of viewing this quantity is that if the total current were ***uniformly distributed*** from the surface inward, at such a density that the rate of heat development is the same, then the lower boundary of the current would be at one penetration unit from the surface. For this reason the unit is sometimes called the ***depth of current penetration*** although of course this term is a bit misleading.

The value of the penetration unit varies with the frequency and with the electrical and magnetic properties of the conducting material. Table 1 lists values of penetration units for a few common metals at a number of different frequencies.

TABLE 1 VALUES OF PENETRATION UNITS FOR SEVERAL METALS

(Penetration units in mils)

Material	60 Cycles	1 Kc	100 Kc	1 Mc	10 Mc
Copper	300	80	8	2.5	0.8
Aluminum	450	120	12	3.5	1.2
Brass	700	180	18	5.5	1.8
Steel (cold)	65	15	1.5	0.4	0.15
Steel (hot)	3200	750	75	24.0	7.5

It can be seen immediately that high frequencies are ideally suited for heating surfaces. This fact alone is not so important because in most heating problems the heat is applied at the surface. The advantage of induction heating lies in the high efficiency and convenience with which the heat can be applied. By the use of the induction heating process, heat can be applied so rapidly that the high temperatures can be confined to the surface layers. Thus in problems such as the casehardening of steel, the surface layers of the work may be brought to the hardening temperature in such a short time that the inner parts of the work may remain relatively cool and unchanged. Moreover if the heating cycle is short enough, the heat is conducted so rapidly from the high-temperature layer into the cooler interior that self-quenching may result and liquid-quenching materials are then unnecessary.

RANGE OF FREQUENCIES USED

At present the frequencies used for induction heating range from about 60 cycles per second to several million cycles per second. For frequencies up to about 15,000 cycles, motor generator sets are the most common type of power source, although recently mercury-vapor tubes are being used to develop high powers in the 1000 to 2000-cycle range. For frequencies between 30,000 and 100,000 cycles, spark-gap generators are perhaps the best type of equipment. For frequencies above 100,000 cycles, the electronic type of power generator is the only satisfactory source of power.

HARDENING THIN SHELLS

After examining Table 1, one might at first infer that since the penetration unit in hot steel at, say, 1000 cycles is $^3/_4$ in. it would be impossible to harden a layer $^1/_4$ in. deep at this frequency. However, such is not the case. If energy is applied at fairly high power levels so that thermal conduction does not complicate the picture too much, the most of the current is confined within a layer which has been heated above the Curie point.

Note, for example, the curves shown in Fig. 1. These curves show the approximate distributions (in depth) of current density and temperature when the heating is so rapid that thermal conduction does not complicate the process. Here the surface has been brought just to the Curie point and the temperature at any point is purely a function of the square of the current density at that point.

Now let the heating be continued. A short time later the forms of the relationships are as shown in Fig. 2.

It will be seen that the current density is at a peak at the junction of the magnetic and nonmagnetic steel. This high-intensity front moves inward as the steel heats. Thus Fig. 3

shows the approximate distributions at the time when the Curie point has penetrated a distance almost equal to one current penetration unit.

It is seen that if the heating had been stopped at any intermediate time, the depth of hardened layer would have been approximately equal to the distance to which the hardening temperature had penetrated at that time.

Thus a hardened case one tenth of an inch or more in thickness may be produced with a frequency of a thousand cycles per second. It is not possible however to produce fully hardened shells of, say, 10 to 20 mils thickness by following this technique and using extremely high power concentrations and very short heating times because of the behavior of steel at high current densities.

The curves just referred to were drawn on the basis that the permeability of cold steel is about 200. At very high power concentrations, however, the magnetic-flux densities are so great that the steel may be far beyond its saturation point. Therefore, the effective permeability may be near unity even for the cold steel, if the power concentrations are in the order of 100 kw per sq in.

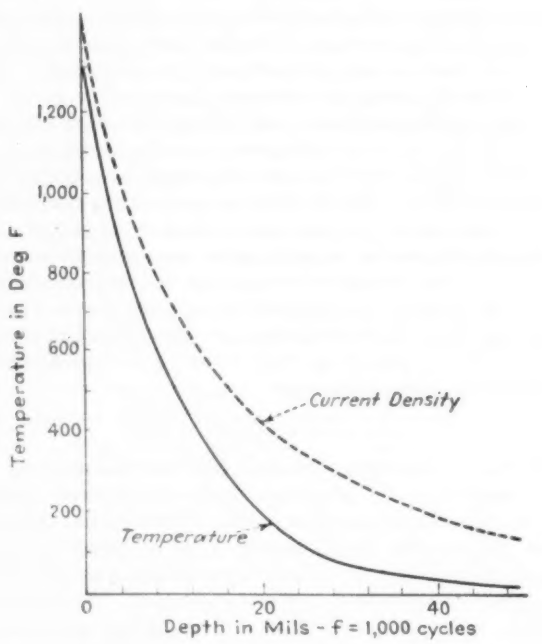

FIG. 1 CURVES SHOWING APPROXIMATE DISTRIBUTIONS (IN DEPTH) OF CURRENT DENSITY AND TEMPERATURE

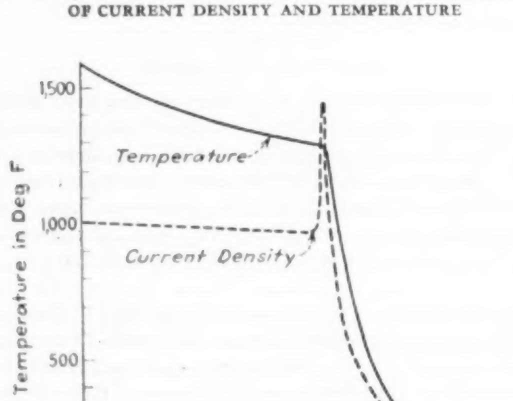

FIG. 2 APPROXIMATE DISTRIBUTIONS OF CURRENT AND TEMPERATURE, BASED ON FIG. 1, WHEN HEATING IS CONTINUED

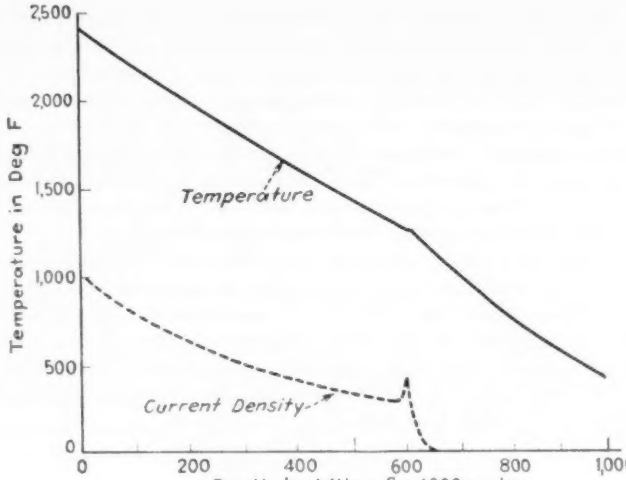

FIG. 3 APPROXIMATE DISTRIBUTIONS OF CURRENT AND TEMPERATURE, WHEN CURIE POINT HAS PENETRATED A DISTANCE ALMOST EQUAL TO 1 CURRENT-PENETRATION UNIT

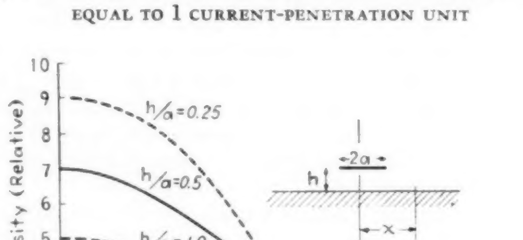

FIG. 4 LATERAL DISTRIBUTION OF INDUCED CURRENT

At very high powers the distribution of current and temperature is much like that shown in Fig. 1 with the exception that the depth of penetration is 500 mils, instead of 20 mils. Therefore, the use of high power concentrations may be partially offset by the increasing depth of current penetration at the higher powers. The only solution to the problem of hardening thin shells therefore is the use of radio frequencies where the depths of current penetration are small even though the powers are high. For this reason radio-frequency power sources are being developed. Thus it is found that at frequencies of 400 or 500 kilocycles hardened shells from 10 mils up to 40 mils in thickness can be produced in S.A.E. 1050 steel by the self-quenching method. And by using a water quench, the depth of hardened layer is limited only by the hardenability of the steel.

The heating can be controlled in lateral area as well as in depth by high-frequency induction. The curves of Fig. 4 show this lateral distribution when the inductor is a thin ribbon of width $2a$ and is spaced a distance h above an infinite plane. It can be seen from the curves that if the inductor is $^1/_4$ in. wide and is spaced $^1/_{16}$ in. from the work, more than 80 per cent of the heating effect is located in a strip $^1/_4$ in. wide immediately beneath the inductor. Such localization is useful in operations such as welding, brazing, or soldering.

EFFECTS OF FREQUENCY

It was stated that frequency may have an effect on the efficiency of energy transfer to the work and we have just seen that frequency is important in controlling the depth and extent of

the heated volume. Therefore, let us consider this factor in some detail.

Frequency affects the transfer efficiency if the work is so thin, compared to the depth of current penetration, that an appreciable amount of the magnetic flux penetrates clear through the work. For example, consider the induction heating of a thin steel ribbon. Let us say the strip is 5 mils thick and $^1/_2$ in. wide, and that the heating is accomplished by wrapping the inductor in several loops around the strip. Assume the frequency to be one megacycle. It will be found that the strip heats quickly to a dull-red-color temperature and then just refuses to get any hotter. The temperature is slightly above the Curie point and the efficiency of energy transfer is only a few per cent of what it was when the steel was in the magnetic state.

The reason for this drop in efficiency can be seen from a simple analysis of the situation. Since the inductor is wrapped around the strip, the induced currents flow across one face and back in the opposite direction across the other. When the strip is cold, the current penetration unit is only about 0.4 mil and therefore approximately 99 per cent of the magnetic energy is absorbed within a depth corresponding to the half thickness of the strip. On the other hand, when the steel is hot and nonmagnetic, the current penetration unit is 24 mils and in a half thickness of the strip only about 18 per cent of the magnetic-flux energy is converted into heat. The other 82 per cent is canceled by the flux which penetrates from the opposite side.

In order to couple energy into the hot strip with high efficiency, the current penetration unit should be equal to or less than one fifth of the total thickness. This means that a frequency of several hundred megacycles is necessary to heat the 5-mil strip in the manner described.

In other cases the frequency may be too high for the size of the work. Again let us take a specific example. Suppose that 100 kw are to be applied to a steel cylinder 4 in. in diameter and that the frequency is again one megacycle. The inductive reactance of even a single-turn 4-in. inductor coil becomes quite large at this frequency. In fact it will be found that in order to feed 100 kw into the work the voltage across the single loop must be near 1000 volts. For a close spacing between coil and work this voltage is likely to cause arcing, especially when the work is hot. A wider spacing greatly decreases the coupling to the work and results become worse rather than better. The solution to the problem is the use of a lower frequency.

There are many other difficulties encountered with high-frequency effects. In some cases where the work is very small it may be impossible to use as high a frequency as desired because of the difficulty of coupling megacycle energy into the work. At frequencies of several megacycles, electrical energy becomes quite elusive and an "inductor" coil may in reality turn out to be an electrical capacity.

It is evident, therefore, that all sizes of work cannot be heated by any given frequency; it is necessary to select the frequency according to the size of the work. It should not be inferred, however, that this size-frequency relationship is a critical one. For example, a 500-kilocycle current works well on cylinders between 4 in. and $^1/_2$ in. in diameter.

CONCLUSIONS

It is felt that the experimental side of induction heating is considerably ahead of the theory. This is due largely to the extremely laborious calculations which are involved in the latter. Since so many different factors enter the problems, only rough approximations can be made at best.

The conduction of heat is usually thought of as a slow process, but when the temperature gradients are in the order of those necessary to produce the thin hardened shells described, then we find that heat travels at astonishing rates.

At the present time, the maximum power concentrations which can be developed are not much more than 100 kw per sq in. However, the results obtained by the use of such high power concentrations fully justify their use in many important cases, and it now seems worth while to attempt to reach even higher concentrations.

HIGH-SPEED HEATING

Summary of Discussion of Foregoing Papers

IN connection with the presentation of three papers on the general subject of high-speed-heating techniques, at the 1944 Annual Meeting of the Society, and published in this issue,[1,2,3] the following summary of discussion at the meeting is given:

Prof. W. Trinks[4] commented upon the sensitivity of certain alloy steels to high-speed heating, and suggested that further work be done in connection with determining the maximum rates of heating which the so-called "tender" steels can stand. Mr. Hess[1] acknowledged that high-speed gas-air heating experiments and installations had so far been restricted to the simple carbon steels and a limited number of alloy steels (such as S.A.E. 4340), and to billet thicknesses of not more than 8 in. He agreed that the more delicate steels might well be investigated, but emphasized that no evidence of deleterious effects of heating had yet been found despite persistent seeking. Professor Trinks also noted that most high-speed gas-air units to date accommodate only one or a few workpieces at a time, and therefore high production is attained only by using a multiplicity of units; a potential disadvantage in the light of the trend toward continuous processes. Mr. Hess replied that several continuous installations are currently being made, and, although single-piece units have been the rule to date in this new field, there existed no reason why high-speed gas-air heating techniques could not be adapted to continuous processing as widely (if not more so) as any other heating technique. He added the belief that mechanical engineers will be obliged to develop practical, simple, and durable work-handling mechanisms of new types, capable of operating in extremely high temperature zones.

Professor Trinks noted that Dr. Paschkis' method[2] of analysis was based on average thermophysical properties and did not account for their variations with temperature, phase transformations, etc. Dr. Paschkis replied that, although this was true, a method involving 6 parameters had just been completed to correct for such errors, but seemed to indicate so far that the simpler and faster method of utilizing average figures checked

[1] "Fuel-Fired Techniques and Their Possibilities," by F. O. Hess, appears on pages 442–444 of this issue.

[2] "Time-Temperature Relationships in Work Pieces," by Victor Paschkis, appears on pages 445–447 and 452 of this issue.

[3] "High-Frequency Induction Heating," by W. M. Roberds, appears on pages 448–451 of this issue.

[4] Projects Director, A.S.M.E. Research Committee on Forging of Steel Shells and Demolition-Bomb Bodies, Pittsburgh, Pa. Mem. A.S.M.E.

closely and definitely within the limits of current engineering requirements.

Professor Trinks also noted that, despite all the heating engineer's effort to attain uniform heating throughout large pieces, he often worked against himself by permitting, for example, the piece to be handled after heating in contact with cool rolls which chilled one side of the workpiece only and resulted in such final-part defects as eccentricity, nonhomogeneous structure, and the like. He also observed that it is not always most desirable to have the skin or exterior parts of a workpiece at highest heat, as, for example, in blanks for piercing to tube or shell (here the hotter and more plastic core serving to keep the piercing tool centered).

A further comment of Professor Trinks related to the fact that induction-heating processes would result in nonuniformities if tube stock being heated thereby were to vary in thickness from one side of the tube to the other, or from lot to lot; and such variations in the material being heated might well exceed the niceties of heating technique under discussion. He also asked whether induction heating would be efficient in heating coiled or laminated material where partial electric insulation (through oxide layers or air spaces) existed between laminations. Mr. Roberds[3] replied that limitations in this direction did exist and that the problems of interlocking electrical fields and obstructed current paths could be quite real. The cost and life of capacitors for low-frequency induction-heating work were brought up.

Mr. Hess noted that the techniques of high-speed heat transfer by gas-air combustion had developed more rapidly than appropriate part-handling methods and appropriate control instruments. The problem of continuously recording part temperature during part movement and in extremely short time intervals, sometimes in open apparatus and sometimes in greatly confined furnace enclosures, has proved difficult in the engineering of automatic control for the class of equipment under discussion at the symposium.

Mr. Roberds proposed the possibility of installations combining both high-frequency induction heating and high-speed combustion heating on, for example, heavy work where fuel-fired techniques could efficiently bring the whole part to just below the critical point, and induction methods carry the surface quickly into the hardening range.

W. S. Aug[5] introduced the possibility of utilizing metals other than copper for induction-heating coils. Mr. Roberds acknowledged the possibility of using tungsten so that it could be brought up to high temperature and add the radiant effect of its incandescence to the strictly inductive-heating influence. He indicated that silver offered so little advantage over copper in reducing heat absorption by the coil that the additional cost was not warranted. It was also observed that it is necessary to keep copper coils cool during induction heating, because their resistivity goes up with temperature and may unbalance the circuit or render it inefficient.

F. J. Orzel[6] inquired about the cost of induction heating, and was supplied with two crude figures based on experience: 400 kwh per ton of metal in forging practice; and 5 cents per kwh total operating, maintenance, and equipment cost for sustained high production.

Cecil Rhyne, Jr.,[7] stated that the presentation and discussion thus far had indicated that a steel heated to the Curie point and immediately quenched was hardened and that the times to reach this point by induction heating had been mentioned as fractions of a second. It was his understanding that to complete transformation of the steel, time was required and with rapid heating, unless the steel was heated somewhat above the normal hardening temperature, the material would not be hardened at all upon quenching.

M. C. Moffett[8] inquired about the effect of induction heating upon a scrap or faggot pile (as in the manufacture of wrought iron). Mr. Roberds replied that the efficiency of such heating had never been high due to the near-insulating boundaries between pieces. He indicated that work which was self-quenched rather than quenched by liquid immersion never attained full hardness, but frequently resulted in beautifully gradual transitions of metal structure and was, therefore, frequently most desirable in many classes of current war work.

Dr. Paschkis suggested that Mr. Hess use the more accurate phrase of "diffusivity," in lieu of "conductivity," in discussing the different heating results obtained during otherwise identical tests on the brass, copper, and cupro-nickel billets referred to in his paper.

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[6] Engineer, H. A. Brassert Co., New York, N. Y.

[7] Industrial Heating and Welding Engineering Division, General Electric Company, Schenectady, N. Y. Mem. A.S.M.E.

[8] Coatesville, Pa.

Time-Temperature Relationships in Workpieces

(Continued from page 447)

Parenthetically, it should be stated here that similar conditions prevail in cooling, with the difference that in the heating procedure the degree of uniformity achieved is mainly an economic question. If heat is applied sufficiently slowly, any reasonably expected uniformity can be achieved. The rates of cooling, however, particularly in quenching, are by and large taken out of the hands of the furnace engineer. These rates and uniformities are in most cases determined primarily by the geometry of the piece and, if a certain rate is desired at the surface, the rates in the interior follow automatically and cannot be influenced. If they are not satisfactory, change of design and geometry of the piece is the only way out.

Studies of temperature uniformity and rate of heat flow in heating and cooling can be and have been carried out on the Heat and Mass Flow Analyzer, the technique of which has been repeatedly described.

ACKNOWLEDGMENT

The calculations in the section, "Time of Exposure," were developed in part from charts by M. P. Heisler, which as yet have not been published.

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RADIAL RAKE ANGLES *in* FACE MILLING[1]

2—*Tool Wear, Chip Formation, and Cutting Speed in Carbide-Steel Milling*

By J. B. ARMITAGE[2] and A. O. SCHMIDT[3]

HIGH cutting speeds, from 1000 to 3500 surface ft per min, have been reported and frequently recommended for steel-milling operations. In many instances, behind these recommendations is the belief that definite advantages can be realized from extremely high cutting speeds. From this investigation and observation of numerous production operation setups, we have found that speeds between 1000 and 3500 fpm are not to be generally recommended for carbide-steel milling.

One of the primary factors in determining cutting speeds for steel is the power actually available at the machine spindle. A second factor which must be considered is the type of cut to be taken, i.e., either roughing or finishing. Surface finish of the workpiece very often determines the selection of proper cutting speeds and feeds.

In rough-milling operations on steel, the heaviest cut compatible with the condition of the machine and available power should be taken. The use of heavy feeds per tooth, from 0.010 to 0.015 in., at cutting speeds from 350 to 750 fpm, will require less power to remove a given amount of metal per unit time than operations at higher speeds with smaller chip loads.

Operations with heavy chip loads will generally result in coarser finishes than high-speed operations with light chip loads. However, if a relatively good surface finish is desired recommended practice would indicate a heavy roughing cut to be followed with a light high-speed finishing cut.

FACTORS AFFECTING TOOL LIFE

Numerous factors have definite effects on the life of the tool between regrinds. Mechanical failure, under which breaking, cracking, checking, or fracture of the tool tip may be grouped, is most commonly encountered in tool breakdown. Such failures may have several sources: improper handling or grinding, extremely hard workpieces, incorrect grade of carbide, excessive vibration in the cut, and cutting edges not designed, or incorrectly designed, for the operation at hand. However, although these factors have been investigated and their detrimental effect reduced to a minimum, there are others, invariably present, which will affect tool life in any cutting operation. Among these are the friction between the chip and the blade face and the heat generated by the friction, both of which are concentrated in the zone immediately around the cutting edge. They generally will cause tool failure more rapidly at high cutting speeds than at low cutting speeds.

It has been pointed out[4] that the temperature at the cutting edge of a tool varies directly as the cutting speed although the temperature of chips of uniform cross section remains approximately the same. Bases for this statement are thermoelectric and calorimetric measurements of cutting temperatures and power consumption. However, the foregoing statement holds true only as long as the shape of the cutting edge remains unchanged. During the tests from which the conclusion was derived, a maximum of only 0.3 cu in. of metal per tip was removed. For this reason the cutter could reasonably be considered as unchanged during the cutting operation.

In an actual cutting operation, however, such an ideal condition never exists. As soon as a few chips have been removed the tip has undergone slight changes and the new cutting angles are different from the original cutting angles.

TESTS SHOWING EFFECT OF CUTTING ON TOOL

A series of tests which illustrate the effect of cutting on the tool were performed on a Kearney & Trecker 50-hp C.S.M. vertical milling machine. A fly cutter 10 in. in diam was provided with a solid-carbide blade. The carbide was of a type which in previous experiments had shown little tendency toward mechanical failure when cutting steel. This was an important consideration since the object of these tests was to study the effect of the friction and the accumulated concentrated heat in the zone immediately around the cutting edge. In all cases a new sharp blade was used for each test at a given cutting speed. Negative radial and axial rake angles and a 15-deg peripheral cutting-edge angle were used for all tests. A vise was used to hold the S.A.E. 1020 cold-rolled steel, Bhn 180, test block 12 in. long and 3 in. wide.

The results can best be interpreted by analyzing the relief views of the cutting edges, Figs. 2 to 9, inclusive. In all tests a uniform feed per tooth of approximately 0.010 in. was maintained, while the depth of cut was constant at 0.150 in. Two passes were made over the test block with each blade removing a total of 10.8 cu in. of metal. Cutting speed was changed for each cutting blade and ranged from 130 to 3280 fpm. Fig. 1 is a relief view of the tip as it appeared before each test, after having been ground with a diamond wheel.

The influence of cutting speed on chip formation relative to

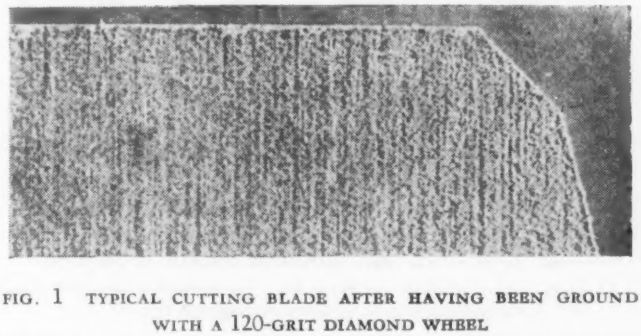


FIG. 1 TYPICAL CUTTING BLADE AFTER HAVING BEEN GROUND WITH A 120-GRIT DIAMOND WHEEL

(Cutting edges were not honed; surface finish 9 to 12 microinches. Length of blade face shown is approximately 0.150 inch.)

[1] Section 1 of this paper appeared on pages 403–406 of the June, 1945, issue of Mechanical Engineering.

[2] Vice-President in Charge of Engineering, Kearney & Trecker Corporation, Milwaukee, Wis. Mem. A.S.M.E.

[3] Research Engineer in Charge of Metal Cutting Research, Kearney & Trecker Corporation. Mem. A.S.M.E.

[4] "Measurements of Temperatures in Metal Cutting," by A. O. Schmidt, O. W. Boston, W. W. Gilbert, presented at a meeting of the Chicago Section, A.S.M.E., Chicago, June 17–19, 1945.

Contributed by the Production Engineering Division of The American Society of Mechanical Engineers.

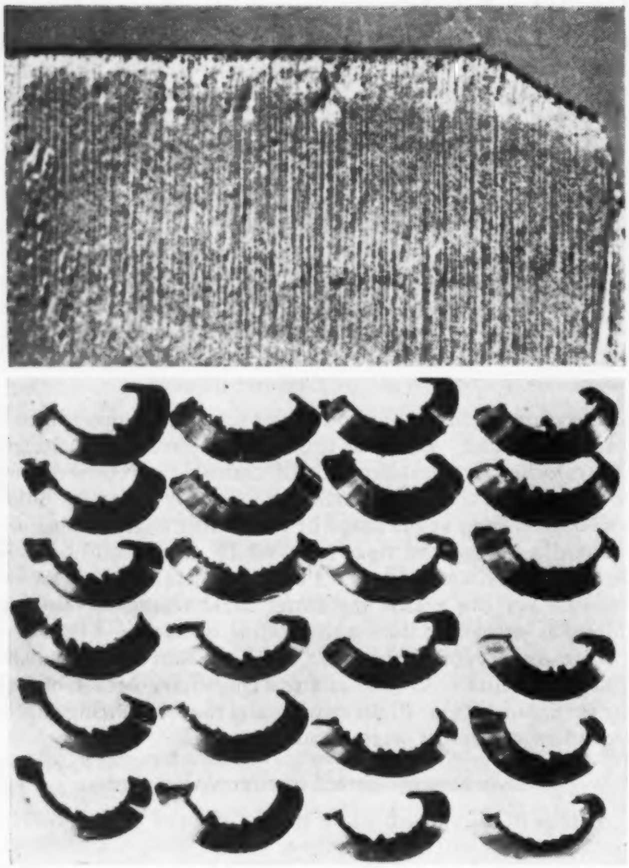


FIG. 2 CUTTING EDGE AND CHIPS FORMED AT 130 FPM
(Small particles on blade face are remnants of built-up edge. Chips are more compressed and thus shorter than at other speeds.)

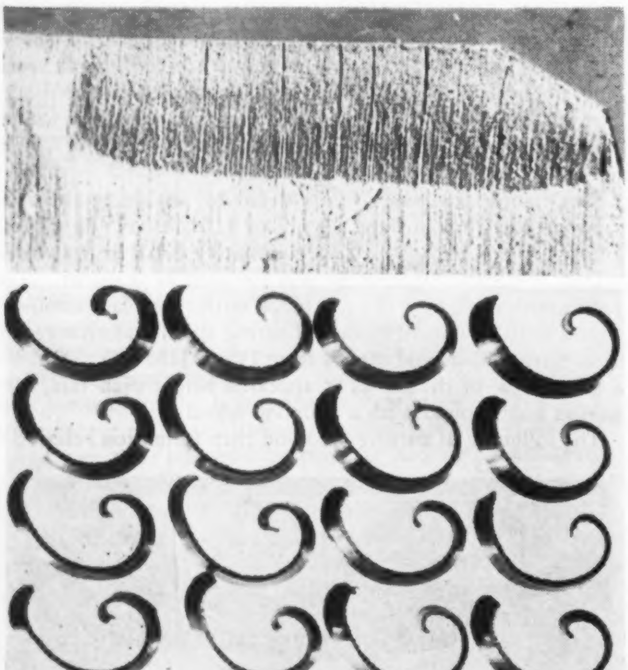


FIG. 3 CUTTING EDGE AND CHIPS FORMED AT 582 FPM
(Abrasive action of chips on blade face has formed a shallow crater. Chip formation is uniform throughout the cut.)

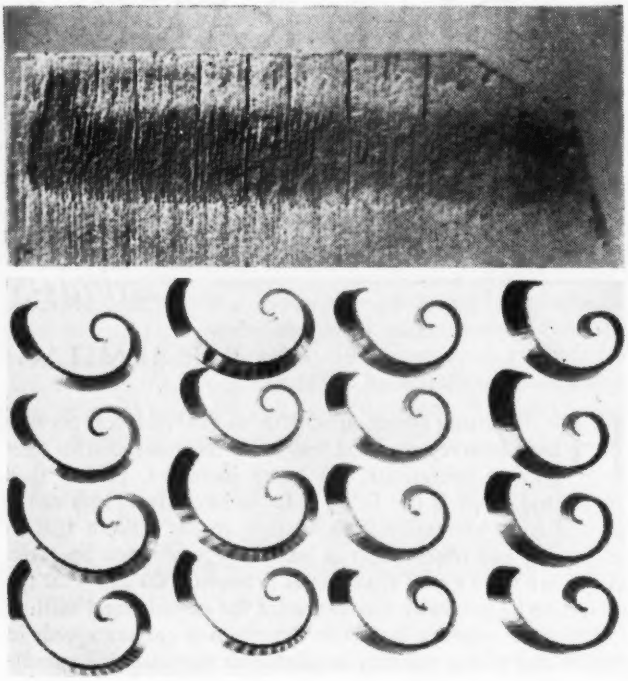


FIG. 4 CUTTING EDGE AND CHIPS FORMED AT 895 FPM
(Crater is more pronounced. Chips are uniform and somewhat oxidized.)

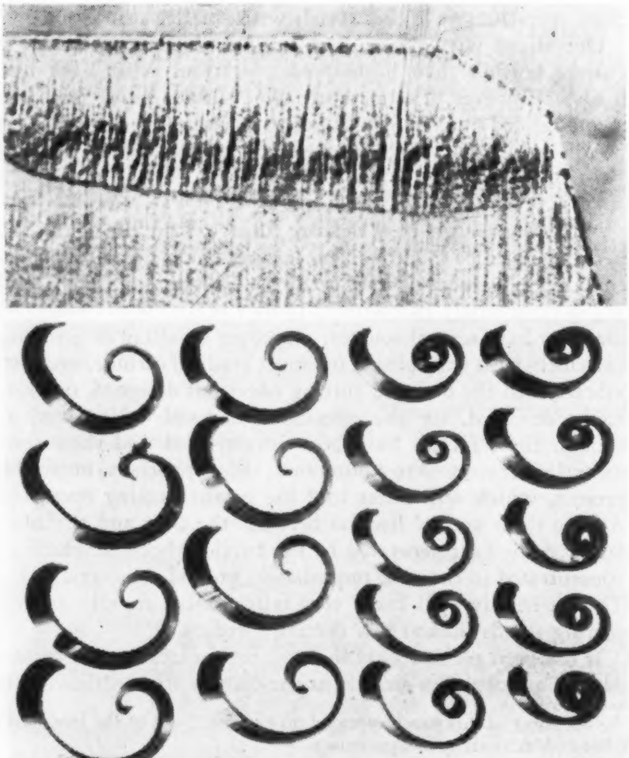


FIG. 5 CUTTING EDGE AND CHIPS FORMED AT 1385 FPM
(Depth of crater is approximately 0.015 in. Chips are uniform at first but tend to curl more tightly as crater depth increases.)

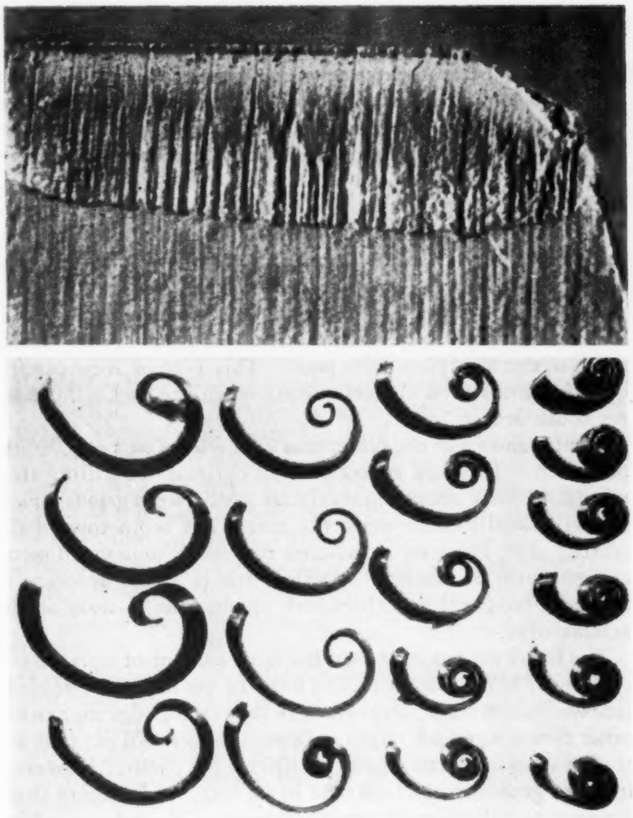


FIG. 6 CUTTING EDGE AND CHIPS FORMED AT 1720 FPM
(Crater depth is about 0.025 in. Chips tend to curl earlier in cut because of more rapid formation of crater.)

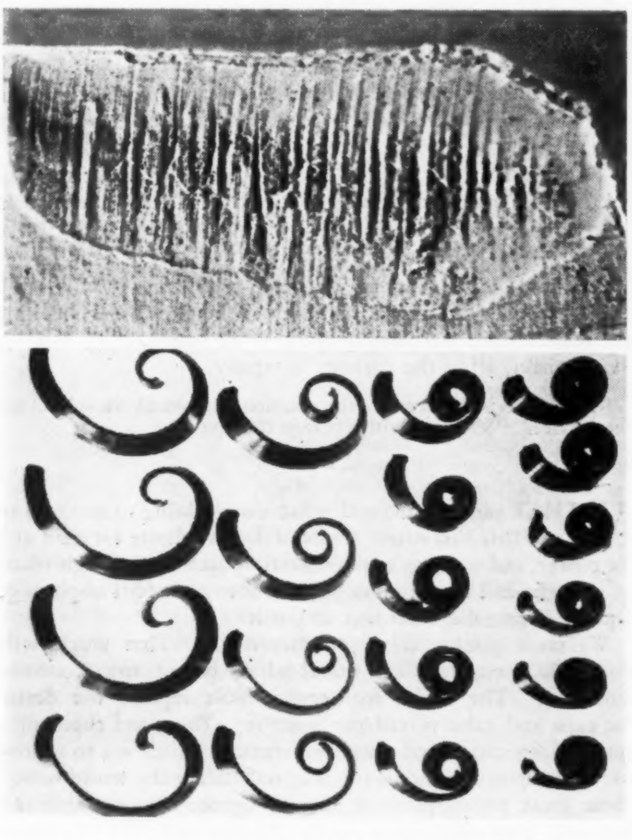


FIG. 7 CUTTING EDGE AND CHIPS FORMED AT 2140 FPM
(Crater 0.040 in. deep has been formed. Chips tend to curl tightly near end of cut.)

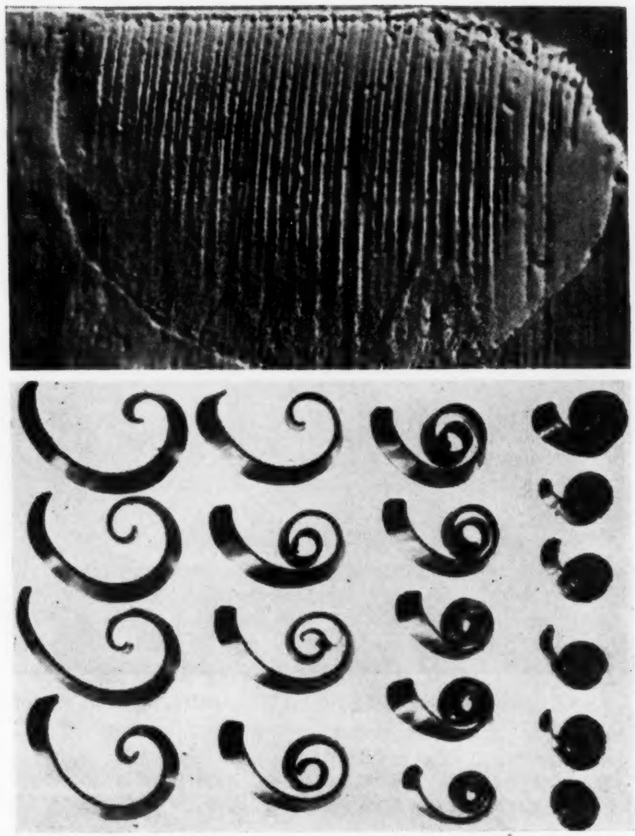


FIG. 8 CUTTING EDGE AND CHIPS FORMED AT 2650 FPM
(Crater, approximately 0.050 in. deep, has pronounced influence on tightly curled chips.)

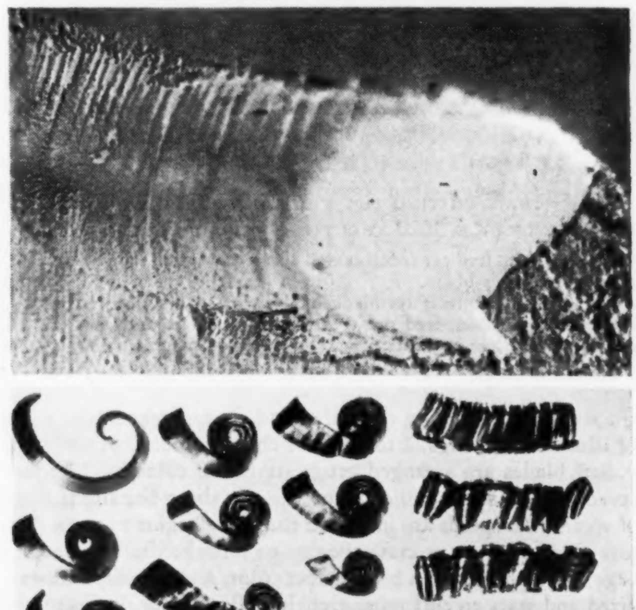
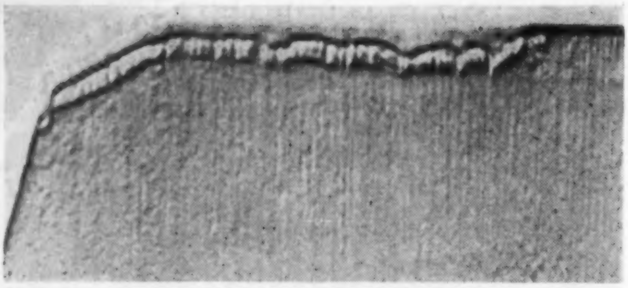
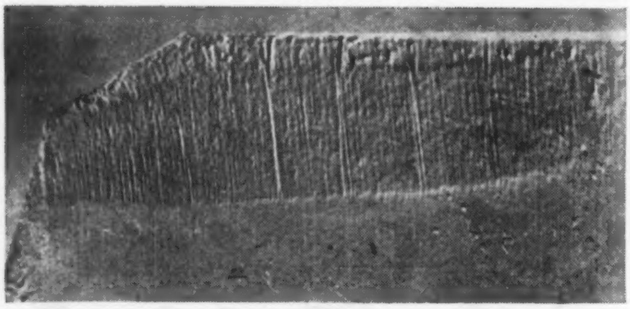


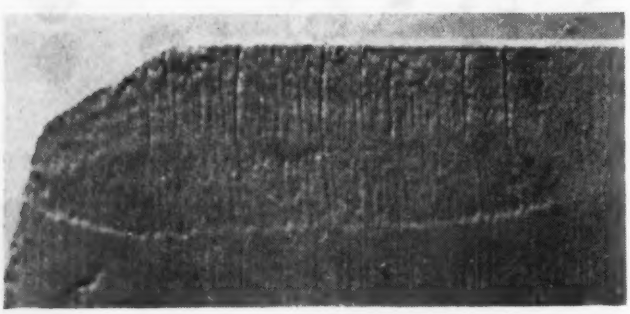
FIG. 9 CUTTING EDGE AND CHIPS FORMED AT 3280 FPM
(Only 4 cu in. of metal was removed in 5 sec of actual cutting time before cutting edge of this blade failed completely. Rapid deterioration of cutting edge is illustrated in chips formed. Crater was too deep to permit better photography.)



(*a*)



(*b*)



(*c*)

FIG. 10 THREE CUTTING TIPS WHICH HAVE REMOVED 10.8 CU IN. OF S.A.E. 1020 AT CUTTING SPEED OF 680 FPM

(*a*, A 0.0005-in. feed per tooth caused abrasive wear on land behind cutting edge of this blade. *b*, A 0.010-in. feed per tooth shows only a slight amount of wear on blade face, none on land behind cutting edge. *c*, A 0.020-in. feed per tooth shows wear starting farther back on blade face than in either of other two tips. Length of crater is approximately 0.150 inch.)

the wear at the cutting edge of a blade is apparent in the series of illustrations, Figs. 2 to 9. The chips produced by the individual blades are arranged progressively in columns. At low speeds the chips are uniform and the tips show but slight signs of wear. As speeds are increased the blade begins to show definite signs of wear, a crater begins to form behind the cutting edge, the tip takes on a blue temper color, and the chips are oxidized and start to curl more tightly. Because of the increased speeds and higher temperature of the cutting edge, the abrasive action of the moving chip tends to wear the tip away more rapidly. As this wearing dulling action continues, chips tend to alter in shape to conform to the crater being worn into the blade. Depth of crater after removing a given volume of metal varies almost directly as the cutting speed.

However, if the test at 130 fpm had been continued the blade would probably have failed by spalling, chipping, or breaking because of vibration in the cut before much abrasive wear or cratering had occurred.

At 3280 fpm the cutting blade removed only 4 cu in. of metal in approximately 5 sec of actual cutting time before complete failure of the cutting edge. A gradual change is noted in the chips formed as the cutter passes through the workpiece. Chips have become extremely overheated and oxidized. A crater almost $^1/_{16}$ in. in depth was worn into the blade face; temper colors gave an indication of the high tip temperature caused by accumulation and concentration of heat in the cutting tip.

Fig. 10 shows three tips which have removed 10.8 cu in. of S.A.E. 1020 at a cutting speed of 680 fpm, but with a different feed for each tip. The upper view shows the wear encountered when the feed was 0.0005 in. per tooth. This feed caused gradual abrasive wear on the land behind the cutting edge. It had worn enough so that the dimensional accuracy and surface finish of the workpiece were poor. This type of wear can frequently be observed in steel milling when the feed is 0.002 in. per tooth or less.

The tip shown in the center was used with a feed of 0.010 in. per tooth. This feed generally is an optimum in milling steel up to 200 Bhn in obtaining maximum life between grinds. Failure will usually occur when the crater has worn toward the cutting edge, but prior to failure a reasonable amount of metal can generally be removed. During this time the accuracy of the work produced undergoes little change due to wear at the cutting edge.

The lower tip has machined the same amount of metal as the two above it but with a feed of 0.020 in. per tooth. The blade face wear starts much farther behind the cutting edge than in the other two tips, which might indicate a longer tool life than for the tip working with a feed of 0.010 in. per tooth. However, it can be generally observed that in milling, steel chips of these dimensions will bring about failure because of cracking, which indicates that the feed per tooth is too heavy.

CONCLUSIONS

1 An analysis of the illustrated results indicates that there is an upper and lower limit of cutting speed in steel-milling practice at which cemented carbides will give best results.

2 A cutting speed of approximately 500 surface ft per min will result in good chip formation.

3 As the cutting speed is increased, wear at the cutting edge and consequently changes in tool angles become more pronounced.

4 A fine chip of 0.0005 in. thickness will cause more abrasive wear at the cutting edge than a coarse chip of 0.010 in. per tooth.

ACKNOWLEDGMENT

Grateful acknowledgment is made to Messrs. J. R. Roubik and J. P. Bunce for help in carrying out these tests and checking the manuscript; the photographic work was done by Mr. W. Skowronski, all of the authors' company.

NOTE: This is the second of three sections into which the subject has been divided. Section 3 will appear in the next issue.

WHAT can be done and what are we doing to bring to an end this disastrous result of human desire for gain and for power, and to bring our civilization back to the high plane of thought and action upon which those great philosophers of ancient Greece did their best to put it?

We must quickly create another world. That world will put moral principles and moral ideals before any economic ambition. The desire for service must replace the desire for gain and take precedence over it. Then, and then only, can our generation and those generations which are to follow look out upon a world in any way resembling the world which those great philosophers of ancient Greece contemplated and to which they offered inspiration and guidance.—Dr. Nicholas Murray Butler at the 191st Commencement of Columbia University, June 5, 1945.

WAR PROBLEM *of Increasing Utilization of* SMALL ANTHRACITE[1]

By J. F. BARKLEY[2] and WILLIAM SEYMOUR[3]

On February 23, 1944, Solid Fuels Administrator, Harold L. Ickes, stated that it was necessary to utilize about 1,000,000 tons of freshly mined anthracite ranging from barley (No. 3 buckwheat) downward through the smaller sizes in order (1) to relieve a huge and growing surplus of industrial sizes of anthracite that threatens to cut vitally needed production of domestic sizes unless new markets can be found, and (2) to supplement the available supply of industrial sizes of soft coals to help meet the growing needs of war plants and other industries. To help move these sizes of anthracite, surplus tonnages are being purchased by the Defense Supplies Corporation of the Government and are being marketed by the Solid Fuels Administration at prices equal to those of bituminous coal on a Btu basis.

Table 1 lists sizes of Pennsylvania small anthracite, their principal uses, and the estimated total amounts sold in 1943. The sizing used in the table for No. 4 and No. 5 buckwheat has just recently been adopted as standard. The table therefore lists only approximate figures for the various tonnages for the sizes as given.

TABLE 1 ESTIMATED ANNUAL TONNAGES OF SMALL ANTHRACITE SOLD IN 1943[a]

	Size		
Use	$^3/_{16} \times {^3/_{32}}$ Barley	$^3/_{32} \times {^3/_{64}}$ No. 4 buckwheat	$^3/_{64} \times$ X No. 5 buckwheat
Stokers	5,064,900	1,905,700	0
Pulverized coal	0	654,600	481,500
Hand-fired	424,900	5,400	0
Mixed with bituminous coal	1,900	16,900	0
Briquetting	4,400	263,800	11,400
Ore sintering	98,300	84,000	74,700
Manufacture of carbon electrodes	15,200	800	800
Manufacture of chemicals	1,100	0	0
Manufacture of foundry facings	0	0	2,700
Coke-blending	0	0	16,300
Special uses (not specified)	113,300	5,700	2,700
Total	5,724,000	2,936,900	590,100

[a] From figures supplied by the anthracite industry.

Increasing the quantity of anthracite utilized for any of the uses listed in Table 1 would be helpful. Substituting barley for rice (No. 2 buckwheat) wherever possible, particularly for these uses, is desirable. As a practical matter, however, it is necessary to develop other uses. The Bureau of Mines at present is working on four projects:

(*a*) The burning of mixtures of small anthracite and bituminous slack on stokers.

(*b*) Methods of producing and burning "packaged fuel" made from anthracite fines.

(*c*) The use of anthracite fines in the production of coke.

(*d*) The use of barley anthracite in gas producers.

BURNING MIXTURES OF ANTHRACITE AND BITUMINOUS COAL ON STOKERS

The effects on combustion, on underfeed stokers, of adding barley anthracite to bituminous-slack coal can be somewhat anticipated from a study of the factors involved. The barley-coal particle is hard, slow-burning, and noncaking. An average analysis of barley coal shipped from collieries of members of the Anthracite Institute is given in Table 2.[4]

TABLE 2 AVERAGE ANALYSIS OF BARLEY ANTHRACITE

	Dry coal					British thermal units			Softening
Size	Moisture as received	Volatile matter, per cent	Fixed carbon, per cent	Ash, per cent	Sulphur, per cent	As received	Dry coal	Moisture- and ash-free	temperature of ash, F
Barley	7.2	4.4	82.0	13.6	0.7	11980	12890	14920	2880

The bituminous coal in the eastern region of anthracite availability is, in general, a caking coal with a considerable range of volatile, of ash, of Btu content, and of ash fusion. The addition of barley would therefore be expected to (1) decrease caking; (2) decrease pressure drop through the fuel bed; (3) decrease manual attention to the fuel bed of single-retort stokers; (4) decrease smoke; (5) increase fly ash; (6) increase combustible in fly ash and refuse; (7) affect the clinkering favorably; (8) affect the load-carrying capacity; (9) affect the over-all efficiency.

The extent to which these effects occur would depend on such factors as the percentage of anthracite used, the type of equipment, and the load and the characteristics of the bituminous coal being burned.

Studies on the burning of mixtures of barley anthracite and bituminous slack on underfeed stokers, both single-retort and multiple-retort, have been proceeding for some months. The effect on the caking of adding a small amount of anthracite is of much more consequence with the single-retort type of stoker with or without side dumps, than with the multiple-retort end-dump type. Single-retort equipment is essentially a device for pushing coal up over a grate; it lacks the adjustment possibilities of the multiple-retort end-dump type Eastern coals, in general, cake so much that an erratic fuel bed is formed on the single-retort stoker that requires frequent manual attention to maintain a desirable fuel bed. Adding anthracite in the right amounts makes possible a better fuel bed, from the standpoint of caking. The addition for these stokers of some 15 per cent of barley is usually sufficient to open up the fuel bed and give little trouble from caking. As higher percentages of anthracite are added, the fuel bed approaches the typical noncaking anthracite bed.

Experiments on a side-dump single-retort stoker under a

[1] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

[2] Chief, Division of Solid Fuels Utilization for War, Bureau of Mines, Washington, D. C. Mem. A.S.M.E.

[3] Chemical Engineer, Bureau of Mines, Pittsburgh, Pa.

Contributed by the Fuels Division and presented at the Semi-Annual Meeting, Pittsburgh, Pa., June 20, 1944, of The American Society of Mechanical Engineers.

[4] "Quality of Anthracite as Prepared at Breakers Operated by Members of the Anthracite Institute in 1935," Report of Investigation 3283, Bureau of Mines, July, 1935.

520-hp boiler gave a decreased pressure drop through the fuel bed, as shown in Fig. 1. The bituminous coal used had a volatile content from 22 to 24 per cent and an ash from 14 to 16 per cent on a dry basis; the barley, a volatile of about 7.5 per cent and an ash of 13.5 per cent. The ratings on the boiler varied a little, as shown by the percentage figure at each plotted point. This illustration should not be taken as indicative of all installations and conditions. Further detailed studies are necessary to bring out all the factors involved as regards this item.

Fig. 2 shows for various percentages of anthracite, the total number of times the fuel bed was manually broken up or poked in 8 hours, with the resulting CO_2 content of the flue gases. The stoker was a small stationary dead-plate single-retort stoker, installed under a 200-hp horizontal-return-tubular boiler. The boiler was being operated by the regular plant firemen carrying the usual plant load of about 100 per cent boiler rating. In this case about 50 per cent anthracite gave good results and the management decided to use this mixture continuously.

Fig. 3 shows the average percentage of smoke density plotted against the percentage of anthracite for a large side-dump single-retort stoker. The bituminous coal used had a volatile of about 23 per cent on a dry basis. Since these percentages are average smoke densities for 8-hr tests, they are all fairly low. Such stokers should be able to handle high-volatile coal with only spasmodic production of smoke. During these tests, carrying the regular plant load, there was No. 5 smoke on all tests using bituminous coal only. The average time of emission per hour varied from 10 sec to 4 min. This was also true of No. 4 smoke, except that the average time of emission per hour reached as high as 6 min. With the anthracite mixtures there was no No. 5 smoke, and with the exception of two tests with anthracite mixtures, no No. 4 smoke was produced. These two tests had an average emission of 3 and 5 seconds per hour of No. 4 smoke. No. 3 smoke was produced on all except three tests, the longest average time of emission per hour for a mixture being about 2 minutes.

Fig. 4 shows the increase in fly ash, expressed as percentage of dry coal burned, as the ratio of anthracite increased. This curve applies to the installation described in Fig. 1. The curve is indicative only, as all of the fly ash was not caught by the simplified type of collector used.

Fig. 5 shows the increase in unburned combustible in the fly ash with increase of anthracite for the same set of tests shown in Fig. 4. Fig. 6 shows the increase in unburned combustible in the ash and refuse from the stoker for two series of tests. The upper curve for the single circles applies to the installation in Fig. 1, a large single-retort side-dump stoker; the lower curve for the double circles applies to the small dead-plate stoker in Fig. 2. All tests were for plant-operating conditions using the usual plant firemen. When using mixtures it is desirable to give increased attention to the burning out of combustible before the refuse is dumped.

Although laboratory experiments on the intimate mixing of ash from different coals show that the resultant ash fusion cannot always be anticipated from the ash fusion of each coal, in general it was found that clinkering conditions were improved on the side-dump underfeeds by the admixture of anthracite. Most anthracite has a relatively high ash fusion; intimate mixture of the ash does not necessarily occur on the stoker; decreasing caking in the fuel bed tends to prevent excessive hot spots, thus lowering ash temperatures.

The load-carrying capacity of the stoker is affected by the percentage of anthracite used. If the bituminous coal has a higher Btu value and a lower ash content than the barley to be added, the resultant Btu value of the mixture drops as the percentage of anthracite increases and the amount of ash to be handled increases. This results in less load-carrying capacity. To offset this, the improvement in the caking for some installations makes possible even better load-carrying capacities when the lower percentages of anthracite are used. If the bituminous coal is as high or higher in ash content than the barley, higher percentages of anthracite can be used more effectively. Anthracite is a slower-burning fuel than bituminous; this acts to lower the load-carrying capacity. As a practical matter, however, many installations of the single-retort type of stoker are not being pushed to the limit of their load possibilities.

Under regular plant-operating conditions many factors affect the over-all efficiencies. As a broad general statement, the efficiencies obtained on single-retort stokers with a reasonable range of anthracite admixtures were about the same as with straight bituminous. Gains in better fuel-bed conditions tend to be offset by increase in unburned combustible. If fuel-burning efficiency only is being sought, usually a percentage admixture of anthracite for such stokers can be determined that will give an efficiency somewhat higher than that of a caking bituminous coal. On one series of tests with rear-dump multiple-retort stokers, running at low ratings, the same efficiency, i.e., 78 per cent, was obtained with a bituminous coal of about 25 per cent volatile and 13 per cent ash as with a 50-50 mixture of the coal with barley anthracite.

The percentage of anthracite that should be mixed with bituminous coal for a given installation depends on many factors such as the availability of needed amounts of bituminous coal, the load to be carried, and the type of equipment. It should be determined by trial for each installation. Appropriate stoker and damper adjustments for the changed burning characteristics of the fuel must necessarily also be determined on such trials.

To the plant operator an important part of the problem of burning mixed fuel is that of obtaining the mixture. Mixing usually must be done right at the plant. How much of a problem it is to mix the fuels depends on the plant layout and the equipment available. In general, relatively simple schemes provide sufficiently thorough mixing for stoker use. It is a mistake to conceive the needed mixture to be 100 per cent thoroughly uniform fuel before entering the stoker; it should not, however, have large segregated batches of anthracite. Considerable mixing occurs in the stoker itself. The higher the percentage of anthracite, the more careful must be the external mixing.

The more times the fuel by proper plan is dumped or is turned over on its way to the stoker, the better the mixture. Where a truck is to be used to dump the coal into a hopper or bin, a layer of chosen height of anthracite can be loaded into the truck, followed by a layer of bituminous slack to fill the truck. Upon dumping, these layers mix. Conveyers frequently afford good methods of mixing. Where one conveyer can spill a stream of anthracite onto a stream of bituminous carried by a second conveyer, mixing will be obtained when these two streams are finally dumped from the second conveyer. Each plant must be given individual consideration, the factors involved being of a nature to require only rather simple study.

METHODS OF PRODUCING AND BURNING "PACKAGED FUEL" MADE FROM ANTHRACITE FINES

In 1943 a total of 2,163,998 net tons of briquets, and a total of 215,605 net tons of packaged fuel were manufactured; 592,050 net tons of anthracite and semianthracite fines (28.5 per cent of the total raw fuels) were used in the manufacture of briquets.[5] Practically no anthracite was used in the manufacture of packaged fuel.

The production of briquets is the result of many years of experience during which the economics of the process as applied to the United States have dictated its development to the present stage. Some of the plants now in operation which have not used any anthracite fines are now considering the admixture of these fines with their low-volatile bituminous coal; this

[5] Mineral Market Report, M.M.S. No. 1175, 1943.

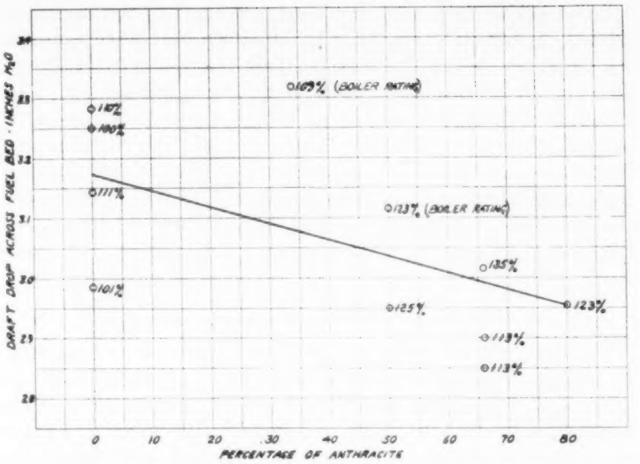


FIG. 1 DECREASED PRESSURE DROP THROUGH FUEL BED OF LARGE SIDE-DUMP SINGLE-RETORT STOKER AS PERCENTAGE OF ANTHRACITE INCREASED

(The ratings on the boiler are shown by the per cent figure at each point.)

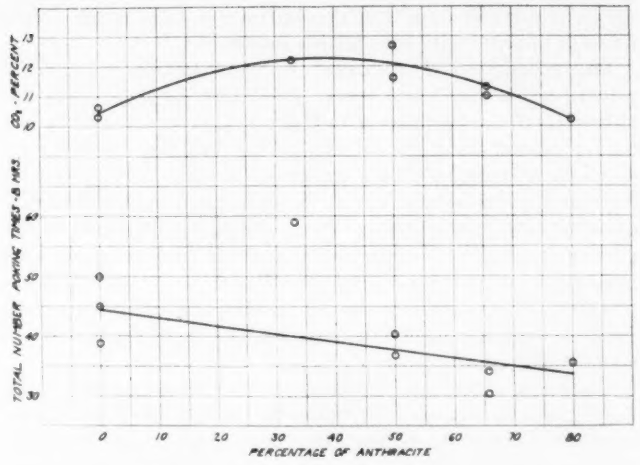


FIG. 2 TOTAL NUMBER OF TIMES FUEL BED OF SMALL STATIONARY DEAD-PLATE SINGLE-RETORT STOKER WAS MANUALLY BROKEN UP IN 8 HR FOR DIFFERENT PERCENTAGES OF ANTHRACITE, AND RESULTING CO_2 OF FLUE GASES

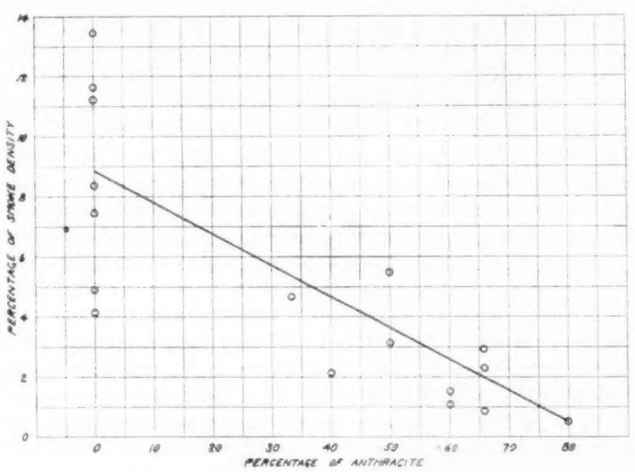


FIG. 3 PERCENTAGES OF SMOKE DENSITY FOR DIFFERENT ANTHRACITE PERCENTAGES FOR A LARGE SIDE-DUMP SINGLE-RETORT STOKER

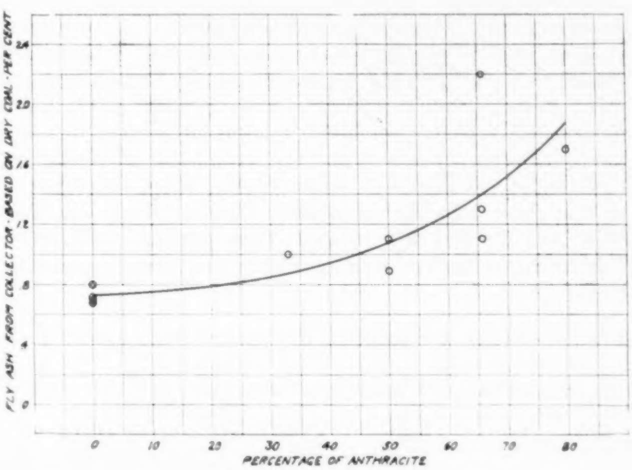


FIG. 4 QUANTITIES OF FLY ASH CAUGHT IN COLLECTOR FOR DIFFERENT PERCENTAGES OF ANTHRACITE FOR LARGE SINGLE-RETORT STOKER

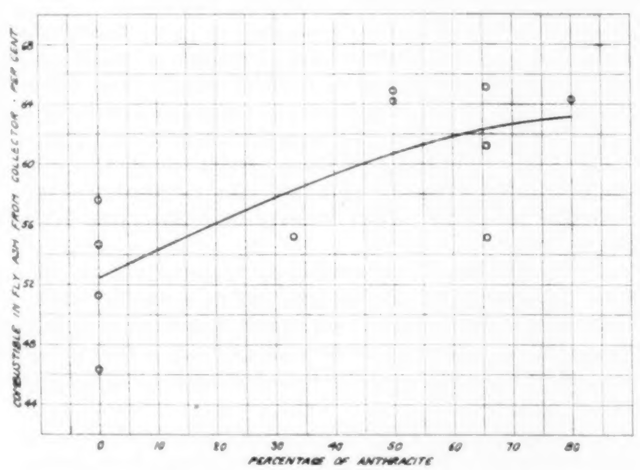


FIG. 5 INCREASE IN UNBURNED COMBUSTIBLE IN FLY ASH WITH INCREASE IN ANTHRACITE FOR LARGE SINGLE-RETORT STOKER

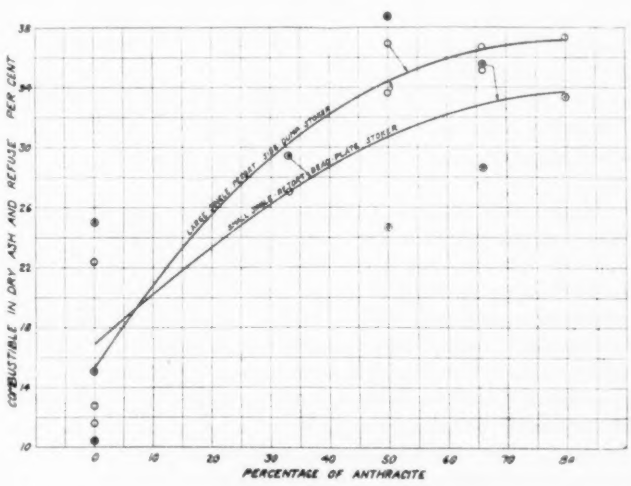


FIG. 6 INCREASE IN UNBURNED COMBUSTIBLE IN ASH AND REFUSE WITH INCREASE IN ANTHRACITE

will undoubtedly result in the utilization of a much larger tonnage of anthracite fines in this industry.

The production of packaged fuel has had a phenomenal growth in the last 7 or 8 years. Its development has been due chiefly to the demand for a method of making use of the fine coal produced at docks or coalyards, resulting from the rescreening and sizing of coal for domestic use. It has proved a popular fuel on account of its cleanliness in handling and ease of storage and distribution. Since the coal block used in the package is produced with lower pressures and in larger sizes than the regular briquet, the initial cost of equipment is appreciably lower, making its use possible by the smaller coalyards. The block is more friable than the briquet and will not stand rough handling.

To date, this fuel has been manufactured almost entirely from Pocahontas screenings. Recently the Bureau of Mines in cooperation with a large industrial company has been experimenting with the production and testing of packaged fuel containing various percentages of anthracite fines. No major difficulty was experienced in the manufacture of blocks from these mixtures. The facilities of the Pittsburgh Station have been used to investigate the properties of the packaged fuel made in these experimental runs in a commercial plant. The physical and chemical tests of the fuel include compressive strength, specific gravity, porosity, a modified tumbler test, proximate analysis, and ash fusion. In addition, tests made under the direction of W. T. Reid, in a laboratory furnace simulating a hot-water boiler, show the burning characteristics of these coal blocks under strictly controlled experimental conditions. Such tests yield data on rate of burning, production of smoke, and tendency of the blocks to maintain their shape when hot, as well as other information valuable in determining the suitability of the fuel for various home-heating applications. Table 3 shows the various mixtures used in these experimental blocks.

TABLE 3 COMPOSITION OF COAL BLOCKS

Sample no.	Anthracite, per cent	—Bituminous coal— Per cent	Kind	Asphaltic binder, per cent	Remarks
5[a]	. .	95.8	Pocahontas	4.2	Strongly coking
11	63.0	34.0	Pocahontas	3.0	Strongly coking
7	84.0	13.7	Pocahontas	2.3	Noncoking
10	84.0	13.3	Pocahontas	2.7	Noncoking
14	82.0	12.0	Pocahontas	6.0	Noncoking
18	40.0	55.5	Illinois	4.5	Coking
12	61.0	36.0	Illinois	3.0	Weakly coking
9	80.0	14.0	Illinois	6.0	Noncoking
16	50.0	43.5	Ohio	6.5	Coking
13	56.0	37.0	Ohio	7.0	Coking
15	72.0	21.0	Ohio	7.0	Weakly coking
8	83.0	1.5	Ohio	5.5	Noncoking
6 and 17	93.0			7.0	Noncoking

[a] Commercial block.

Much study must yet be made to summate satisfactorily the large amount of data taken on these tests. One interesting feature of the burning tests was that when the percentage of anthracite reached 70 to 80 per cent, depending on the character of the coal with which it was blended, the blocks did not fuse together and were entirely free-burning. Figs. 7, 8, and 9 show the residue left after a chosen amount of burning. A study of these illustrations, together with the table, indicates the extent of the caking together of the individual blocks during burning. For example, No. 5, a block of Pocahontas fines, Fig. 3, shows the residue of several blocks caked together. No. 8 having 83 per cent anthracite shows an individual block that was the result of free-burning in the fuel bed. The information obtained from these tests is encouraging. A coal block has been made from straight anthracite with an asphaltic-base binder which, judging from all tests made to date, will be a satisfactory domestic fuel, at least for the higher rates of burning.

Some preliminary tests by a manufacturer of packaged-fuel equipment especially designed for small producers indicate that a satisfactory fuel can be made from anthracite fines mixed with 10 or 15 per cent of bituminous coal and a starch binder. This blend, if adopted by many of the small plants producing packaged fuel, would utilize a considerable tonnage of anthracite fines and would also make available to them a needed source of fuel. One company is considering the erection of a large packaged-fuel plant in the East which would consume a considerable amount of anthracite fines and also help relieve coal shortage.

USE OF ANTHRACITE FINES IN PRODUCTION OF COKE

The effects of the admixture of inert material to coking coals on the coke produced has been the subject of many investigations; anthracite has been considered by various operators as having similar effects. Some producers believe that the use of anthracite fines results in a better product than the use of the same amount of pulverized-coke breeze. In general, it is conceded that small percentages of finely pulverized inerts have little effect on the quality of the coke produced, the most noticeable being the effect on size.

Recently advantage has been taken of this increase of size from the addition of fine anthracite to the coal mixture by several producers of foundry coke to increase their yield of large coke or to obtain the same yield in a shorter coking time. The only published results of such work are given in a paper by I. M. Roberts,[6] in which he describes the work done and the results obtained by the Laclede Gas Light Company, St. Louis, Mo. As part of the Bureau of Mines study two plants were visited that have been able to reduce their coking time by about 5 hours, when using 4 to 6 per cent anthracite buckwheat No. 4 or No. 5 in their blend, without loss in yield of foundry coke.

Owing to the coal shortage, considerable interest has been aroused recently in the use of anthracite fines in the production of blast-furnace coke. During the latter part of 1943 one company ran short of Pocahontas coal and used a mixture of 95 parts of coal having a volatile of about 33 per cent with 5 parts of No. 4 buckwheat anthracite. This blend was used on one third of its production for over a month and apparently this company had no trouble with its blast furnaces. The plant is now using a blend of 80 per cent high-volatile, 15 per cent Pocahontas, and 5 per cent anthracite on all of its ovens and advises that the results are good. It is understood that the oversize (plus $3^1/_2$-in.) is taken out and used for foundry or other purposes.

Several other coke plants producing blast-furnace coke are now making tests of blends containing 3 to 5 per cent anthracite. One of these plants has been using 3 per cent of anthracite for about 2 weeks and has had no trouble with the blast furnaces. Another tried blends containing 5 per cent and then 3 per cent of anthracite; on both, the blast-furnace operation was very poor. The regular coke produced by this company is not especially good owing to high ash in the coals used, and apparently the addition of anthracite gave too high a percentage of inerts.

One plant using 70 per cent Eagle high-volatile and 30 per cent Pocahontas for the manufacture of domestic coke has made several tests with various mixtures containing anthracite fines and finds that a satisfactory coke similar to that produced from the 70-30 mix is obtained from both of the following mixtures:

(*a*) 74 per cent Eagle, 20 per cent low-volatile, and 6 per cent buckwheat No. 5.

(*b*) 70 per cent Eagle, 24 per cent low-volatile, and 6 per cent buckwheat No. 5.

If anything, the anthracite coke from the (*b*) mixture is

[6] "Increasing the Percentage Production of Large-Size Coke at Fast Coking Rates," by I. M. Roberts, Trans. A.I.M.E., vol. 157, Coal Division T.P. No. 1612, September, 1944.

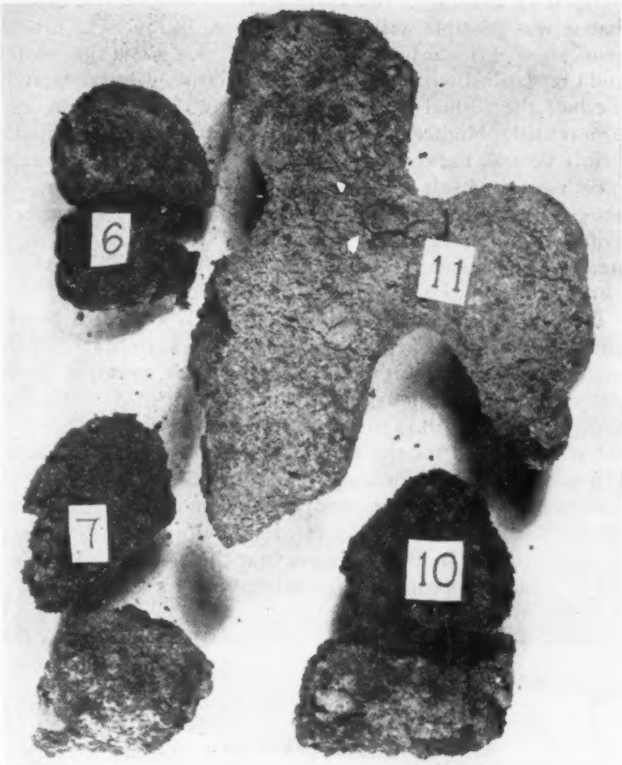


FIG. 7 RESIDUE AFTER A CHOSEN AMOUNT OF BURNING OF VARIOUS PACKAGED FUELS

(The caking together of the individual blocks is indicated by the shape of the pieces of the residue.)

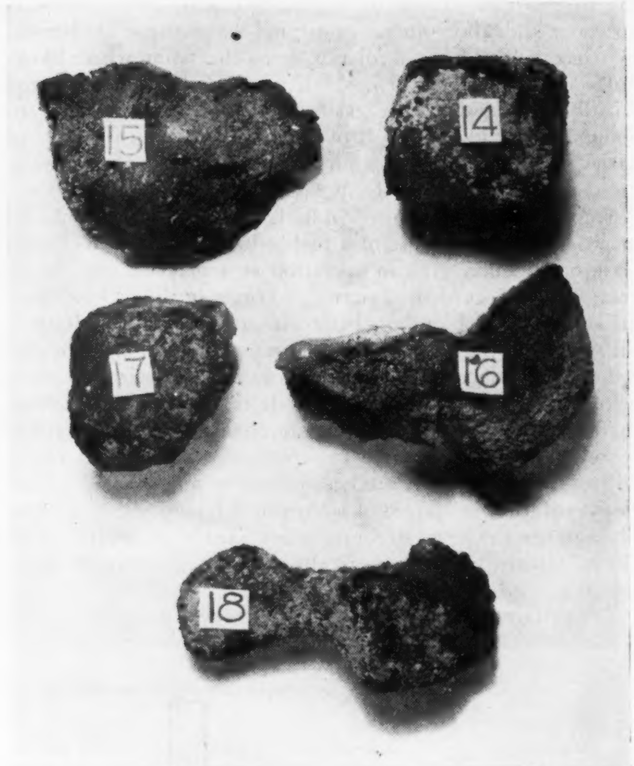


FIG. 8 RESIDUE AFTER A CHOSEN AMOUNT OF BURNING OF VARIOUS PACKAGED FUELS

(The caking together of the individual blocks is indicated by the shape of the pieces of the residue.)

superior since, when crushed into domestic sizes, less breeze is produced.

Where the percentage of Pocahontas or low-volatile coal in the regular blend is low (15 per cent or under), it is customary to reduce the amount of this coal by the amount of anthracite added. Where the normal percentage of Pocahontas or low-volatile is high (above 15 per cent), better results will probably be obtained by increasing the high-volatile when adding the anthracite. Increase in high-volatile coal tends to offset any loss of by-products, owing to the addition of anthracite.

The results available to date on all tests are not sufficient to warrant any definite conclusions, but it seems reasonable to assume that the characteristics of the coking coals used are rather an important factor in the results obtained with the addition of the anthracite. It is believed that the anthracite giving the best results in coking blends is No. 4 or 5 buckwheat with only small percentages of plus $^{3}/_{32}$-in. and minus 80-mesh sizes. Moreover, its volatile matter should be low and the specific gravity high.

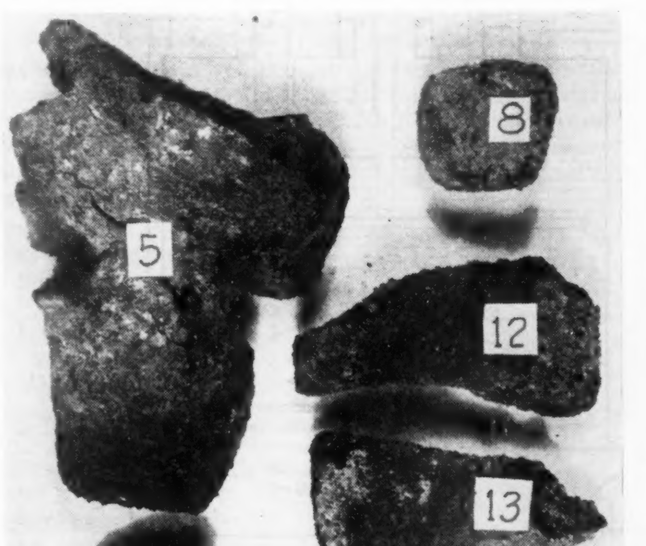


FIG. 9 RESIDUE AFTER A CHOSEN AMOUNT OF BURNING OF VARIOUS PACKAGED FUELS

(The caking together of the individual blocks is indicated by the shape of the pieces of the residue.)

USE OF BARLEY ANTHRACITE IN GAS PRODUCERS

The rated annual capacity of the gas-producer installations in which anthracite is used as fuel is about 45,000 net tons of buckwheat and 600,000 net tons of rice. Very few of the installations are operating below their rated capacities, and it can be conservatively estimated that a market for not less than 300,000 tons of barley might be developed as a result of experiments in progress for the substitution of barley in place of the larger sizes of anthracite now used in gas producers.

The capacity of a gas producer is generally limited by the volumes of air and water vapor that can be blown through the fuel bed. With a water-sealed grate the pressure in inches of water at

the base cannot exceed the depth of the seal. Where there is no water seal, the volumes of air and water vapor are limited by what the fuel bed can tolerate up to the point where blowholes are developed. In general, no difficulty is encountered with blowholes when the gasification rate of rice is held to about 20 lb or less per sq ft of grate per hr. With the use of barley, however, blowholes quickly develop even at much lower rates, making it practically impossible to continue operations.

To permit the substitution of barley for rice, experiments are in progress with the use of a fuel-bed agitator in a Wellman-Galusha producer now in operation at a plant in the eastern area. The object of the agitator or stirrer in the fuel bed is to fill any incipient blowhole before it can become troublesome. Fig. 10 shows the position of the agitator in relation to the fuel bed of the producer. The agitator rotates in a horizontal plane below the surface of the fuel bed. It is attached to a vertical shaft, which is driven by a ratchet mechanism. The mechanism is not shown in the sketch. The speed of rotation can be varied within the limits of the ratchet mechanism and may be as high as 1 revolution in 10 min or as low as 1 revolution in 30 min. The agitator can be set to rotate at any fixed level, or, if desired, can be adjusted to move vertically within certain limits while rotating.

The agitator in the producer under test was placed in service on April 25, 1944, with rice as the fuel. It soon became evident that it was possible with the agitator to increase the rate of gasification of rice at least 25 per cent. It was found that barley could be gasified with the aid of the agitator at approximately one half the normal rate attainable with rice when no agitator is used. Higher rates were not obtainable with the barley mainly because the center of the fuel bed was weak, in spite of or perhaps as a result of the movement of the agitator. The surface of the fuel bed did not have the contour desirable for best results. The center of the fuel bed was overheated, and tests indicated the presence of hard clinker at this location. Meanwhile, the fuel bed was cold along the periphery.

These conditions could not be sufficiently corrected by the agitator alone. The need of modifications was indicated in the method of feeding the producer fuel so as to permit a deeper center. These modifications are now being made. Further tests on the use of the agitator in connection with a barley fuel bed are scheduled for the middle of June, when the operators will have had sufficient time to stabilize the operation. Mr. L. L. Newman, Gas Engineer of the Bureau of Mines, is supervising these tests and has supplied the information herein regarding them. The Bureau hopes that the agitator will prove to be a means of opening additional markets for a large tonnage of barley.

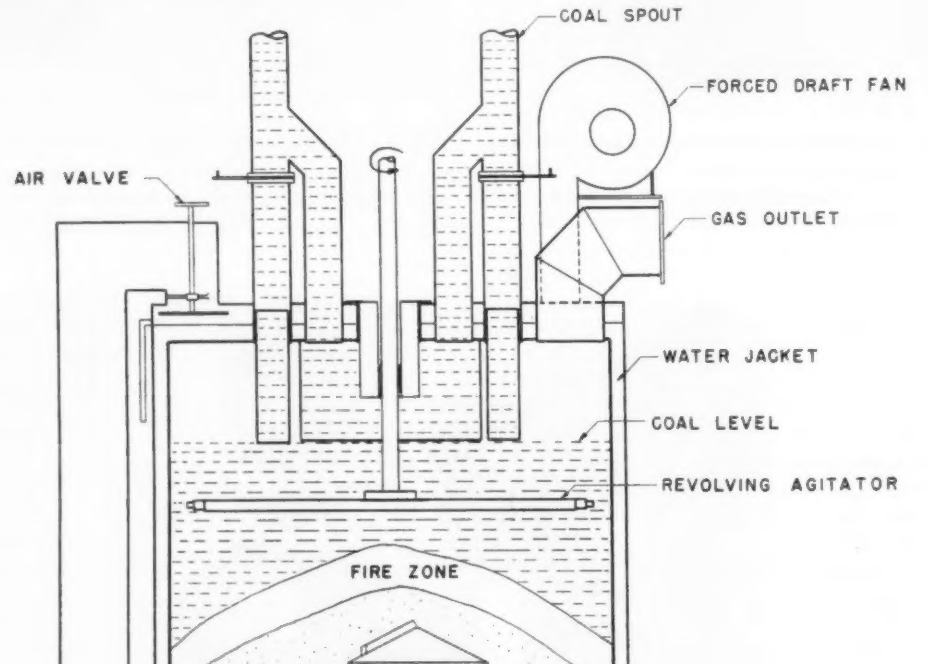


FIG. 10 ANTHRACITE GAS PRODUCER SHOWING REVOLVING AGITATOR

FIG. 1 DC-4 P.C.A. PROPOSED POSTWAR CARGO-PASSENGER TRANSPORT

AIR-CARGO HANDLING

By HARRY S. PACK[1]

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ONE of the most important problems to be solved in the air-line industry is that of air-cargo[2] handling. It taxes and will continue to tax the ingenuity of all concerned. It requires the co-ordinated effort of all, as it is a critical phase of air-line operations. An airplane is not making money, in fact, not even paying its way, when it is sitting on the ground being loaded or unloaded.

Studies have indicated that loading of cargo and servicing are the two time-consuming operations that must be improved. Contrary to previous thinking, the time for passenger loading is not a critical factor in ground time. Tests have shown that a DC-3 with 21 passengers can be loaded or unloaded in 2 to 3 min.

In discussing air-line air-cargo handling, it is most important that all concerned take into consideration one important fact. There is a distinct difference between the materials being handled by A.T.C. and N.A.T.S., and the material that currently is being handled by the air lines, and that will be handled by the air lines in the postwar period. The services are handling much material we hope to handle 10 to 20 or more years after the war, when the elusive 5- and 10-cent per ton-mile rate is achieved. Further, the services are handling some we may never expect to handle commercially, except in emergencies. Military expediency is one thing, sound economics another. In view of this, it is important that speed and flexibility of operations be not penalized by being forced to operate a 10-ton crane when a lighter, faster, 1-ton unit will do the job.

Considering further the general aspects of air-cargo handling and, as further emphasis on the need for improvement, the importance of time necessary to perform the handling operations should be approached from two standpoints:

1 The time required to move an item from its origin to destination, the shipper's primary consideration. Every extra hundred miles that can be brought within the range (in relation to time) of the point of origin, should increase the value to the shipper and the volume for the air line.

2 The time required to load and unload a plane, i.e., ground time at stops, must be subtracted from the hours of plane utilization, the money-making power of the plane and air line. An actual study of this shows that, on a currently operated route, an airplane flew 12.12 hr at a block-to-block speed of 150 mph and accumulated 3.63 hr of ground time, stops for loading, unloading, fueling, etc. The 3.63 hr is 29.9 per cent of the flight time. Comparing this actual operation with that using a proposed airplane with a block-to-block speed of 210 mph, the flying time becomes 8.65 hr, and, assuming the ground time remains the same for the 50 per cent larger plane, i.e., 3.63 hr, the percentage of ground time becomes 42 per cent, obviously reducing the possible hourly utilization of the plane, for if it is flown the same flying time, i.e., 12.12 hr under the same route conditions, the ground time becomes 5.09 hr. This will affect both maintenance and scheduling adversely.

As mentioned before, block-to-block or system speeds serve as an index to the importance of ground time as they affect utilization of aircraft, which is a major factor in determining the revenue-producing ability of an air line. There has been considerable improvement in the aerodynamic efficiency of

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[2] In this paper, air cargo is assumed to be the baggage, mail, express, and company material currently carried, and in the future operations, the same plus heavier "air freight."

Presented at a Joint Meeting of the Aviation Division and Materials Handling Division, under the auspices of the Metropolitan Section, New York, N. Y., March 12, 1945, of The American Society of Mechanical Engineers.

newer, larger aircraft which in turn means higher cruising speeds; this can easily lull one into the belief that system speeds will automatically increase. This is not true, as the larger planes probably will require more time to load unless the present antiquated methods of loading and servicing planes are revised.

Specific examples of the effect of ground time on system speeds of planes in an actual air-line operation show the seriousness of this problem. In studying this matter, the speeds and times were computed for a DC-3 and two other aircraft that will shortly be in service, and which we will designate A and B on a portion of an air-line system operating from Norfolk to Chicago, assuming stops en route. Table 1 shows the effect of ground times of 15 min and 30 min on the system speed for this operation.

time because of the peak periods that have to be met. Personnel utilization is bound to be poor under this arrangement.

This condition indicates the need for consolidation of loads and some form of preloading, i.e., preparation of loads before arrival of the plane. Containers of at least two or three unit sizes would seem to be one answer.

It would be both feasible and desirable to develop a collapsible container weighing a maximum of 1 lb per cu ft. Assuming average density to be 10 lb per cu ft, this would represent only 10 per cent of the pay load. In view of the fact that a load factor of 90 per cent is seldom reached, the resulting saving in personnel and ground time should more than pay for the container and its maintenance. Reduction in breakage of fragile items normally loaded in a bin with heavier pieces of cargo would be another important asset.

TABLE 1 EFFECT OF GROUND TIME ON SYSTEM SPEED

Airplane	System length, miles	Airplane cruising speed,ª mph	Allowance 15 min on ground (elapsed time)	System speed (15 min) mph	Allowance 30 min on ground (elapsed time)	System speed, (30 min) mph
DC-3	789	154	6:11	129	7:11	111
A	789	196	5:02	157	6:02	131
B	789	215	4:39	180	5:39	147

ª No allowance for ground time, i.e., figures indicate average cruising speed for total distance without introducing effect of ground time.

Unfortunately, it is necessary to report that ground times have increased, using the same planes, during the past several years. Of course higher load factors, i.e., more passengers per plane, may be partly responsible, but if this is the case, what will happen when we double the capacity of our planes?

The evidence points out that as the volume increases, the ground operations become more involved and time-consuming, resulting in increased ground time. This trend must be changed.

In considering air-cargo handling in detail, there are several basic phases that must be considered:

1 Ground handling at airport.
2 Loading and unloading the plane.
3 Tie down.

TYPES OF MATERIALS TO BE HANDLED

As mentioned before, it is not logical to expect that we will carry the type of material now handled by the ATC and NATS. Rather it would seem that a certain portion of rail express, parcel post, and truck merchandise will go by air (in addition there will be certain perishable commodities) when the rates go down.

In considering this material, size and weights will determine to a great extent the equipment needed to handle it. Recent surveys indicate a density range of 13 to 17 lb per cu ft, an average size of under 1 cu ft, and an average weight under 10 lb for air express. Rail express is comparable, with a density of 10 to 15 lb per cu ft, between 1 and 2 cu ft in size, and under 20 lb average weight. Truck shipments are directly comparable to rail express.

In view of this, it is hard to see the need for some of the heavy handling equipment currently proposed for postwar air-line use; lightweight is of value in ground equipment as well as in an airplane.

One of the biggest problems facing us in handling this material is the volume of small pieces involved. The amount of handling, under present technique, required to move an item from one airport to another is economically impractical; computations show that usually each piece is handled from 16 to 20 or more times.

Under the present system, it is largely a matter of adding personnel as the volume increases to keep the loading time within certain limits. Obviously, this is economically unsound, as there undoubtedly would be considerable stand-by

With the current trend toward reduced cargo rates, it is obvious that volume will increase. Such an increase, discounting other factors, would be generally at least as the square of the reduction. Add to this the probable movement of all overnight first-class mail by air after the war, probably representing a fivefold volume increase, and include some "air parcel post," and the resulting volume presents a bigger job for the cargo departments.

It is not necessary to wait for the extremely low-cost airplane to see the cargo rates considerably lower; one method of achieving lower rates would be by continuing an extensive use of combination passenger-cargo planes where the cargo would be used as a method of building up the load factor.

It must be remembered that, in so far as the shipper is concerned, the function of air-cargo handling starts at the time and place a package is picked up, i.e., downtown, not at the airport. Improvement in ground time and reduced cost must go hand in hand with airport-to-airport progress.

DEVELOPMENT OF TERMINALS

Every effort must be made to increase the efficiency of a terminal or station through improved design. Flow lines should be carefully worked out to be as direct as possible with a minimum of interfering cross-traffic, and the operation should be mechanized as much as economically practicable. It must be remembered that, in view of the expansion to be expected for a long time to come, what we consider adequate today may be inadequate tomorrow, unless some real planning is done now. All facilities must be appraised from time to time.

The variation in type and size of aircraft complicates apron and terminal design considerably and presents greater problems than do freight cars or trucks. The space requirements are much greater per unit load than for any other form of transportation, so better utilization of space or a revolutionary system is essential. Shorter times at gates or loading docks can only be achieved by co-ordinating the design of the airplane, the ground-handling equipment and the apron-and-station layout.

As mentioned before, preloading, or at least organization of pay-load material, is essential to reduce ground time. To permit rapid and efficient sorting and interchange of material, a good-sized centrally located area, i.e., a cargo room, is necessary. Here loads can be assembled geographically by trips.

Carts, pallets, containers, etc., should be used. Sorting of material on the apron must be eliminated if time and errors are to be reduced.

As volume increases at the larger more active terminals, steps must be taken to mechanize the whole operation.

Another extremely important reason for reducing ground time is the problem of designing airport stations or terminals with a sufficient number of loading positions both from a space and cost standpoint to handle peak-hour loads. When one stops to consider that we are currently working on the design of terminals with 16 loading positions spaced 150 ft apart, capable of expansion to 30 such positions, the problem of handling the interchange of cargo between connecting air lines over the 2400 to 4500 ft of apron is cause for worry. This is mild compared with the proposal that one major airport now being developed should be expansible to 90 plane positions, which, dimensionally speaking, amounts to 14,500 linear ft of apron. A ten-minute connection does not look "too" practical here.

FIG. 3 P.C.A CARGOVEYOR, NEW MECHANICAL AID IN OPERATION OF AIR LINES

It is evident to those involved in planning future airport terminals and related facilities that some radical changes in terminal and even airplane design are going to be necessary to bring about the drastic improvements necessary to put us in the air-line business on a sound economic basis.

Changes, such as nosing into a terminal, loading passengers through a forward entrance from a "second floor" gangway to separate them from cargo flow, and fueling from overhead fuel lines are a few that must be exhaustively studied. Two-floor buildings are almost mandatory for the the more active terminals to separate cargo flow (on ground or tunnel level) from passenger flow and for public movement.

In conjunction with terminal design and procedure, consolidated operation, i.e., loading, unloading, fleet service, etc., handled by one organization serving all air lines, seems to have possibilities. It is seldom that peak hours coincide for all air lines. Even so, a material saving in manpower would result with consolidation. Further, the greater utilization of loading equipment would permit either a larger initial investment, insuring a maximum of mechanization, or a lower total investment, should all air lines purchase their own. More highly specialized and efficient crews could also be developed.

FIG. 2 "BUCKET-BRIGADE" SYSTEM OF LOADING AND UNLOADING CARGO

MECHANIZED LOADING OPERATIONS

Recognizing that unless the "bucket-brigade" system, Fig. 2, of loading through the DC-3 nose door, an opening 22 in. ×

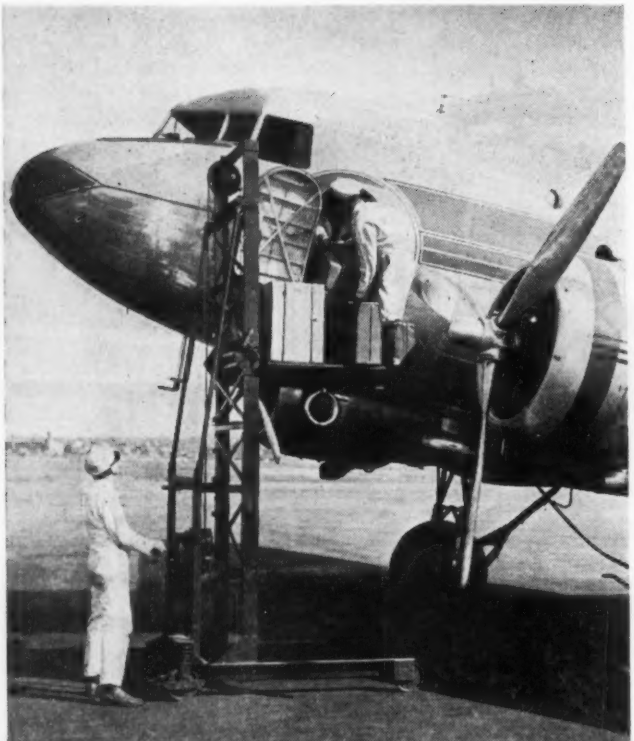

FIG. 4 LIFT-BODY TRUCK REQUIRES COMBINATION WITH TRAILER TO PROVIDE CONTINUOUS-FLOW OPERATION

(As here applied to individual operation, the equipment is not economical.)

38 in. approximately 10 ft above the ground, could be improved, we started developing a mechanized loader to do this job about 2 years ago. In studying this problem, the analysis indicated the need for a flexible movable unit that could load or unload a volume of material with a minimum of personnel effort or precision. The "cargoveyor," Fig. 3, now in use on the P.C.A. system, is a development of this basic thinking. This is a lightweight inclined unit with a reversible endless belt moving at a rate of 60 fpm that moves cargo up to 800 lb up the 25-deg incline for the DC-3. Positive action might damage or jam cargo, so a friction-type belt is used. This conveyer may be used with most other current aircraft. In developing this unit, it was considered essential to be able to maintain a continuous flow of cargo. Also it was decided not to tie up an expensive piece of equipment such as a fork-lift truck or lift-body truck (Fig. 4) for an individual operation.

on-load, which has been moved out to the plane, on the same unit. Experiments to date with chutes indicate that in addition to the use just mentioned, they are valuable for off-loading at points where an entire plane is to be emptied; however, such a station usually justifies a cargoveyor, which is far superior for both loading and unloading.

Although comparisons of different methods of loading are hard to make with any degree of accuracy, Table 2 shows results of tests made using the same personnel in both cases.

The results indicate that on any number of units over 20 pieces, the time for loading or unloading can be cut in half through the use of proper mechanical equipment. A larger loading door would reduce the time still further, as this is now the bottleneck.

At the present time, the human element seems to be largely responsible for the speed of operation, and there is no question but that in addition to all the mechanical aids and improvements in facilities and aircraft, there must be added personnel training, development of loading crews, and organization of work, i.e., establishment of procedures. It is important to have trained personnel at the right place at the right time, doing the right job.

Although the cargoveyor has proved to be an unusually successful piece of equipment, it is not the only effective means of loading aircraft. Further, it is essential that the problem be studied and equipment of many types built and tried; there is no "best way" in sight yet.

One of the most promising and flexible units is the fork truck; there are several versions of this piece of equipment. The A.T.C. has one type in service all over the world (demountable and transportable by plane). Its large pneumatic tires keep it from bogging down in some of the more rugged areas. A large container, Fig. 6, may be filled at any loading point, driven to the plane, raised to doorway, and actually placed inside for unloading.

Another type is used by an air line to raise an empty cargo cart to the entrance where it is loaded, lowered, and moved away. In the meantime, a cart with an on-load is picked up and raised to the door for unloading. This unit requires one more man to operate it, at a speed comparable to the cargoveyor and the flow is not as "continuous," also more maneuvering time is required.

It is conceivable that a series of gravity rollers or even a power-driven, extensible conveyer belt could be used to move material from plane to terminal. This is particularly adaptable to all cargo operations with conventional-type airplanes.

CARGO TIE-DOWN METHODS

A third basic detail of air-cargo handling is the matter of tie-down. Here again the difference between military and commercial air cargo is evidenced. The unit bulk of the mili-

TABLE 2 COMPARATIVE LOADING TESTS

Test	Operation	Time, min: Manual	Time, min: Cargoveyor	Time saved[a] in using cargoveyor: Min	Time saved[a] in using cargoveyor: Per cent	Pieces	Cargo weight, lb	Loading crew
1	On-loading	6	4	2	33	17	686	1 Woman-2 men
1	Off-loading	3	$2^1/_4$	$^3/_4$	25	17	686	1 Woman-2 men
2	On-loading	12	6	6	50	21	995	2 Women-1 man
2	Off-loading	9	4	5	55	21	995	2 Women-1 man

[a] Time saved in using cargoveyor in minutes and percentages.

The latest development is an all-hydraulic cargoveyor unit now going into service. It is moved about the airport, the boom is raised, and the belt is motivated by a gasoline-powered hydraulic motor.

Most air lines have experimented with chutes for unloading. P.C.A. has developed a "one-man" cargo chute, shown in Fig. 5, which is intended for use at smaller stations. It will permit a small volume of off-loading by one man who can also load the

tary cargo makes it essential to position carefully and distribute the loads.

In contrast, the commercial air lines handling many small units bin their loads. This permits rapid and definite positioning with adequate safety; also segregation by destination. This policy has merit in general operation, and is in current use in commercial cargo operation today. Further development in all cargo operation calls for containers. It will be possible

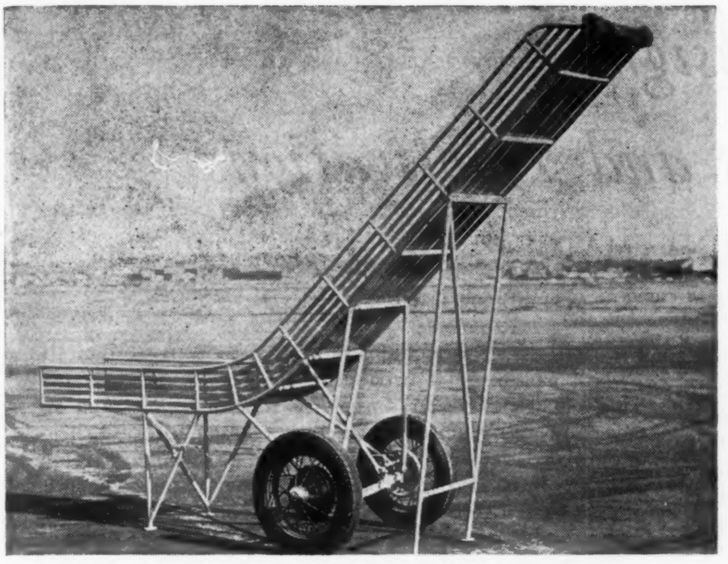

FIG. 5 TYPE OF CARGO CHUTE FOR UNLOADING OPERATIONS

and feasible to snap containers into place. Proper relation of container design to plane design can possibly result in an over-all balancing of weight, i.e., plane weight reduced equal to container. It will still be desirable to have bins for cargo in lots not sufficiently large to warrant containers.

It is essential that any bin system be flexible, i.e., removable and/or adjustable. Quick attachment must be possible, i.e., rings that snap onto studs placed at intervals in the floor; studs also for attachment of belt tie-down or seats.

The relation of aircraft design to air-cargo handling must also be considered. The current air line DC-3, which although it has many limitations has served us well, can be used as an example of the need for balancing design characteristics. One of the current problems is that a cargoveyor is capable of loading 600 lb or more per min, which, unfortunately, is far beyond the capacity of the plane to receive and assimilate. Hence a good portion of the capacity of the loading equipment is wasted. As a point of interest, manual loading with variations for odd sizes averages less than 150 lb per min with a 3-man team.

Another weakness at present is the problem of loading belly compartments. It is probable that the answer to this would be a modification of the compartment that will permit accommodating a reasonable size container. Actually, the best solution would seem to be to lower the entire compartment or sections of it to the ground mechanically.

There are numerous other details that must be kept in mind. If answers can be achieved to the following difficulties encountered in today's operations, we will be well on the way:

1 Time to load and unload through the door of present planes is excessive.

2 Movement of air cargo long distances over the airport is necessary and time-consuming; planes are widely separated because of wing span, taxi clearances, etc.

3 Loading and unloading from carts is necessary for sorting in terminal; excessive number of handling operations.

4 Unloading and loading is necessary for transfer at air-line junction points.

5 The total investment, i.e., complete airplane and crew are held on ground a long time for loading and unloading.

6 Congestion caused by the number of planes on the ground at once; also an excessive number of loading positions required at peak hours because of long ground time.

7 Cruising speeds must be higher to compensate for the longer time on the ground, increasing cost of operation.

8 Time required to compute aircraft weight and load distribution. Although it has been suggested that the planes be loaded on balance scales in the apron, the degree of error introduced by wing and air conditions would probably be too great for acceptance.

There is a great variation in the physical character and dimensions of airplanes, which naturally calls for a variation in facilities, procedures, etc. It is not unreasonable to assume that the air lines must one day make decisions of great import to themselves and to the manufacturers. Questions such as whether all shall nose into a loading position, requiring the passenger door at the front, etc., must soon be resolved.

Economic studies usually prove that the initial cost of a piece of equipment is of minor importance in contrast to the over-all cost of operation, including personnel. This is true also of terminal facilities.

CONCLUSION

The sales factor in air transportation is speed. We go to great effort and cost to gain time in the air; we cannot afford to lose time on the ground. The tempo of the two phases of the operation must be related.

The problem of ground handling in air-line operation has been comparatively neglected in the past, but since the advent of the war it has become a most critical factor directly affecting the utilization of the fleet of air transports where every minute saved in ground and maintenance time has meant another minute more for flying time.

Before the war, mail and express loads were relatively light, but air cargo has increased tremendously during the past few years so that the time for loading and unloading has assumed a major role in air line operations. Little thought was given to cargo space and loading facilities in prewar transport airplanes. This situation is changing; consideration is now being given to aircraft cargo arrangements, ground equipment, and procedures to insure faster, safer, more economical loading operations.

FIG. 6 A.T.C. TYPE FORK-LIFT TRUCK AND CONTAINER

MAGNESIUM *Design*

Considerations and Applications

By JOHN C. MATHES

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GENERAL CONSIDERATIONS AND APPLICATIONS

THE specific gravity of magnesium is 1.8, as compared to 2.7 for aluminum and 7.9 for steel. This physical property is, in most cases, the primary reason for using magnesium, that is, to save weight. There is a wide range of applications where the saving in weight so obtained is of economical importance and where magnesium has been used in the past, and an even greater number is being considered for the future. In most cases these applications are such that the lighter weight is of distinct advantage or usefulness. Ordinarily, static structures or equipment which are not continuously handled or moved do not justify the added expense of the lighter weight.

In addition to the many applications taking advantage of its lightweight, there are certain others where the chemical or metallurgical properties peculiar to magnesium are utilized. Among these special properties are the following:

1 Nonsparking, which makes magnesium desirable for conveyers, hand trucks, or other equipment for handling powder, munitions, or other materials where sparking would constitute a hazard.

2 Nonmagnetic, which makes magnesium suitable for, or near, navigation instruments in aircraft.

3 Etching qualities, which make magnesium suitable for photoengraving plates which etch more rapidly and print as clearly as the more commonly used metals.

4 Machinability, which makes magnesium economical for engraving plates where the mechanical routing constitutes the major cost.

5 Electrical properties, which, because of its specific resistance, make magnesium suitable for certain types of die-cast rotors.

6 Elastic properties, which, because of its low modulus, make magnesium suitable for certain applications where the resultant high energy-absorption capacity is advantageous.

These miscellaneous uses, however, do not constitute the major potential demand for magnesium as an engineering material and this discussion therefore will deal primarily with the design of magnesium as a structural metal, the primary purpose of which is to save weight.

Design. In considering the design of magnesium parts or assemblies it is well to give some thought to the basic qualities of the metal in order to arrive at the best design. The properties of which advantage should be taken are as follows:

1 Magnesium has excellent mechanical properties on a specific-weight basis, and in cast form on an equal-volume basis.

2 Magnesium is readily fabricated and exceptionally easy to machine.

3 Magnesium has the lowest specific gravity of any structural metal.

4 Magnesium has good stability in normal atmosphere.

In order to utilize these favorable properties to the fullest extent, the design should compensate for the somewhat lower shear strength and modulus of elasticity of magnesium alloys by proportioning and distributing the metal to best advantage. The somewhat greater sensitivity to notch effect and stress concentrations requires that details tending to cause them be avoided, particularly under conditions of dynamic loading or fatigue. It is also good practice to insulate properly surfaces of contact with dissimilar metals to avoid galvanic corrosion under conditions of moisture or wetting.

The proper consideration of all of these factors results in a design showing substantial weight savings and a part or assembly that will stand up in service.

Sand Castings. At the present time the largest use of magnesium alloys is in sand castings because in this form the mechanical properties compare most favorably with other metals and maximum weight saving is obtained. Table 1 gives the comparison between the commonly used magnesium and aluminum casting alloys.

TABLE 1 MINIMUM TEST-BAR PROPERTIES

	Dowmetal H		Aluminum 195	
	Solution heat-treated	Heat-treated and aged	Solution heat-treated	Heat-treated and aged
Ultimate tensile, psi	32000	34000	29000	32000
Tensile yield, psi	10000	16000	13000	20000
Ultimate shear, psi	16000	18000	23000	29000
Elongation, per cent	7	3	6	3

From Table 1 it is apparent why magnesium is often substituted for aluminum on an equal-volume basis, and the maximum weight saving of 35 per cent obtained. Ordinarily, most sand castings are fairly stocky so that the lower modulus of elasticity of magnesium is not a problem. The design of magnesium sand castings is essentially the same as aluminum practice, although somewhat more attention should be given to details on castings subjected to high stresses and fatigue. For the general run of castings the shrinkage is so nearly the same that, except for extremely long castings, the same patterns are often used interchangeably for the two metals.

In detailing magnesium castings, the wall thickness should not be less than $^1/_8$ in. for small areas, nor $^5/_{32}$ in. generally, and care should be taken to use adequate fillets in blending sections of different thicknesses or at intersections. This filleting is important to avoid stress concentrations and to improve metal flow so that shrinkage cracks and porosity are avoided. The avoidance of stress concentrations and severe notches is one of the most important considerations in the design of castings and to allow for this the following practice is advisable:

1 To reinforce adequately the free edges of holes or ribs.

2 To use more attachment bolts of small size rather than a few large ones.

3 To use adequate ribs or other means of distributing the loads from the attachment bosses into the main castings. Reinforcing ribs on large areas should be comparatively stocky in order effectively to spread the loads into the surrounding fillet and wall on heavily loaded castings; thin highly stressed ribs should not be used.

4 To use longer studs than are used in materials of higher shear strength, $2^1/_2$ to 3 times the diameter.

Contributed by the Metals Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of The American Society of Mechanical Engineers.

5 To use steel, brass, or other types of inserts on surfaces subject to abrasive wear.

6 To use inserts for bolts or studs that will be frequently removed in service.

7 To avoid sharp corners on machined bosses or faces and, if possible, to use bosses which can be machined off flat.

Sand castings are generally used in the as-cast condition for nonstructural parts because they are the cheapest in the solution heat-treated condition for maximum elongation and resistance to impact, and in the heat-treated and aged condition for highest strength. Growth is not a factor in magnesium castings except for parts that are operated at elevated temperatures. Under these conditions the heat-treated castings will age with some dimensional change, and to maintain dimensional stability aged castings should be specified.

Prior to the war and before the aircraft industry absorbed all of the output, successful uses of magnesium sand castings included cooling fans and hubs for air-conditioning systems, transmission and gear cases, portable tool housings, core boxes and flasks, and movable parts for textile, packaging, printing, and other types of high-speed or reciprocating machinery.

For aircraft the major use has been for engine-accessory, thrust-bearing, and supercharger housings, for landing wheels and landing-gear fittings, for instrument housings, control columns, bell cranks, and many other miscellaneous items.

Die Castings. Magnesium die castings have the same fundamental advantages as are obtained with die castings of other metals. These are as follows:

1 Low per piece cost.

2 Avoidance of machining by casting to close tolerances.

3 Minimum weight by casting sections as thin as 0.050 in.

Magnesium die castings have properties comparable to those of aluminum or zinc and, because of the general use of high-pressure machines, are usually much sounder than ordinary castings made on the goose-neck type. Design practice is essentially the same as previously outlined for sand casting with the additional considerations that walls should be kept as thin as practicable and heavy bosses or sections avoided. This is because the metal chills immediately upon being forced into the die and there is no opportunity for "progressive" chilling to prevent shrinkage porosity in heavy sections, as is accomplished by gating and risering sand castings properly.

Successful applications for magnesium die castings have included vacuum-cleaner and portable-tool housings, typewriter and business-machine parts, couplings and pulleys, camera cases and binocular frames. Aircraft uses have included all types of miscellaneous parts, housings for navigational or other type instruments, and such stressed applications as rudder pedals and small landing wheels.

Forgings, Sheet, and Structural Shapes. If magnesium alloys follow the pattern of the other two structural metals, steel and aluminum, having the same ratio of modulus of elasticity to specific gravity, their maximum application will be found in the form of sheet, structural shapes, or other wrought products. There is no reason why this should not be the case, because various designs to date show that significant weight savings are possible through the use of magnesium for structural assemblies. The design of structural parts is not as simple as with castings, nor are the weight savings obtained quite as large, owing to two fundamental reasons: (1) The mechanical properties of wrought magnesium do not compare as favorably with the other metals as do the properties of castings and, (2) the low modulus of elasticity becomes a significant factor because structural components are, as a class, much more slender and less stocky than castings. Thus the effect of the low modulus must be considered not only to limit deflections to a reasonable magnitude but because allowable stresses, in compression members particularly, are greatly influenced by the stability of the member as a unit as well as locally.

Table 2 illustrates the comparative yield strengths of some commonly used materials:

TABLE 2 COMPARATIVE YIELD STRENGTHS OF METALS

Material	Yield strength, psi	Specific yield strength = Yield strength, / Specific gravity
X-4130 steel	70000	9100
24S-T Aluminum	40000	14300
1025 Steel	36000	4700
Dowmetal O-1HTA shapes	30000	16600
Dowmetal FS-1h plate	24500[a]	13600

[a] Average of compression yield strength and tensile yield strength.

Bending. Table 2 shows that if yield strength alone is the determining factor a nominal gain results from substituting magnesium for some of the other metals. However, in members subjected to bending, substantial weight saving results, because with magnesium a deeper section can be used. While the weight is increasing as the first power, the strength is increasing as the square, and the rigidity as the cube. Thus the somewhat lower mechanical properties and the considerably lower modulus of elasticity are simultaneously accounted for and an equal-strength member obtained with an appreciable weight saving. It becomes a maxim, therefore, that if weight is to be saved by using magnesium for a member in bending some increase in depth of section must be permissible. The amount of weight savings for any particular case will depend on the shape of the section used, the relationship between web and flange thickness, and other details. However, the general situation is presented in Table 3, which compares rectangular sections in bending and is based on the yield-strength values previously given.

TABLE 3 RELATIVE STRENGTH AND STIFFNESS IN BENDING OF STRUCTURAL METALS[a]

Comparison	Material	Thickness	Strength	Stiffness	Weight
Equal thickness	1025	100	100	100	100
	X-4130	100	194	100	100
	24S-T	100	111	34	35
	FS-1h	100	68	22	23
	O-1 HTA	100	83	22	23
Equal strength	1025	100	100	100	100
	X-4130	72	100	38	72
	24S-T	95	100	31	33
	FS-1h	121	100	36	27
	O-1 HTA	110	100	30	25
Equal stiffness	1025	100	100	100	100
	X-4130	100	194	100	100
	24S-T	141	221	100	50
	FS-1h	165	185	100	37
	O-1 HTA	165	227	100	37
Equal weight	1025	100	100	100	100
	X-4130	100	194	100	100
	24S-T	281	880	805	100
	FS-1h	444	1340	1960	100
	O-1 HTA	444	1640	1960	100

[a] Rectangular beams of constant width using 1025 steel as basis of comparison.

Table 3 can be used directly in the design of membrane members whether equal strength, equal stiffness, or the resistance to local buckling is the critical requirement. In all such cases it is seen that the lowest-gravity material, magnesium, can be used to great advantage.

The principle of the utilization of the mass of magnesium without weight penalty has been widely used in aircraft forgings. Even though the mechanical properties of magnesium

forgings are below those of aluminum, there are many cases where the use of magnesium is advantageous from the weight, as well as from the economy standpoint, because to use the higher-strength metals efficiently requires thin sections and webs and perhaps additional stiffeners to obtain the required rigidity. To avoid this complicated and expensive design would result in excessive weight penalty if the sections were made thicker and simpler in the same material. With magnesium, however, a chunky simple forging can be substituted. For example, forged magnesium engine bearers are standard on all German aircraft using in-line engines. It is reported[1] that the main incentive in this development was the desire to combine as many small parts as possible into one larger part and that the resulting forging combined the advantage of economical manufacture with weight saving. Inadequate forging capacity has prevented this particular development in the United States but magnesium forgings up to 10 lb in weight are currently being produced for other aircraft uses such as cargo-door and hoist hinges, flap fittings, etc., which have developed from the same line of reasoning.

In discussing wrought products it is well to mention that magnesium structural shapes are produced by the extrusion process. This permits the desirable practice of designing sections to fit any particular job without being limited to standard shapes. This not only permits sections of maximum structural efficiency but allows the designer to include return flanges, shelf angles, or any other projection required for fabricating, without the necessity of adding them as a special operation. Special shapes for truck bodies and textile machinery are outstanding examples of where this has been done.

As compared to aluminum, magnesium has the added advantage of obtaining extrudable thicknesses without excessive weight penalty, and permitting the use of a single extrusion in place of a section built up from several pieces. This was done with outstanding success on the current model of the famous Douglas C-47 cargo airplane. In this case extruded magnesium floor beams were substituted for built-up aluminum beams. To make the beam extrudable the web is somewhat thicker than necessary for structural requirements. However, the beams are still 5 per cent lighter, and at the same time are 25 per cent stronger and 35 per cent cheaper than the fabricated aluminum beams previously used.

Compression. Magnesium in compression, in a general way, follows the same pattern of comparison as in bending. In short columns where the yield or ultimate strength governs, magnesium columns do not show any great advantage in comparison to the stronger steel and aluminum alloys. However, as the column becomes longer, the same factors of increased properties with no increase in weight react favorably as is the case in bending. The following factors enter into this favorable comparison:

The increased section results in a much smaller slenderness ratio for columns of equal length. As a result, allowable stress is comparatively higher and because of the increased section area, this higher stress is multiplied by a larger area to obtain the total column load. A study of tubes, for instance, of X-4130 steel, 24S-T aluminum, and O-1A magnesium shows that for tubes of equal length and weight and of the same geometrical proportions, the slenderness ratio of the magnesium tube will be 44 per cent of that of the steel and 77 per cent of that of the aluminum tube. In this particular case the magnesium and steel columns were of equal strength at a slenderness ratio of 77 for the steel. For shorter lengths the steel would always be stronger, but for any longer length the magnesium would always be stronger even though in this case we are considering a steel with a compressive yield strength of 70,000 psi and a magnesium alloy with but 20,000 psi. Similarly the aluminum and magnesium curves cross at a slenderness ratio of 70 for the aluminum tube. In a comparison of the magnesium alloy having a yield strength in compression of 30,000 psi, which is available in bars and shapes but not tubing, column curves of round X-4130 steel and O-1 HTA magnesium bars cross at a slenderness ratio of 40 for the steel, and magnesium bars of equal weight are always stronger than 24S-T aluminum.

APPLICATION TO AIRCRAFT

It has previously been shown[2] that for flat sheet in compression, magnesium is 26 per cent lighter than aluminum, and that curved sheet is 20 per cent lighter. Previously, too, the author reported[3] that tests on magnesium sheet-stringer panels showed them to be considerably stronger than 24S-T panels of equal weight. Encouraged by these results the author's company undertook to demonstrate, by the design and construction of full-size wing panels, that magnesium would be structurally efficient for such applications. This work was done in cooperation with the Navy Department, Bureau of Aeronautics, which accepted the final design, tested the wing statically at the Naval Aircraft Factory, and conducted flight and service tests. The success of this program warrants a brief discussion of the design, tests, and service record.

Design Requirements. The wing chosen for this program was the outer panel of the North American advanced trainer, designated as the SNJ-2. The production aluminum wing was of conventional semimonocoque construction with a single shear web located at 30 per cent of the chord. The same type of construction was used in the magnesium wing with the Dowmetal J-1h sheet being used for the skin, ribs, and shear web and Dowmetal O-1 HTA bulb angles, zees, and tees used for the stringers and spar caps. The design conditions were as given in Table 4.

TABLE 4 DESIGN CONDITIONS FOR SNJ-2 WING

Gross weight of airplane, lb	5027
Span (per panel), in.	192.79
Wing area, sq ft	91.24
Aspect ratio	7.03
Applied positive maneuver factor	—5.67
Applied negative maneuver factor	—2.33
Maximum shear, lb	14504
Maximum positive bending moment, in-lb	1220022
Maximum negative bending moment, in-lb	—468856

Material Properties. The magnesium sheet and extrusion alloys used had the minimum properties given in Table 5.

TABLE 5 MINIMUM PROPERTIES OF DOWMETAL SHEET AND EXTRUSION USED IN SNJ-2 WING

Property	J-1h sheet	O-1 HTA extrusions
Ultimate tensile stress, psi	42000	47000
Tensile yield stress, psi	32000	30000
Compressive yield stress, psi	20000	30000
Bearing allowable, psi	60000	60000
Shear, psi	20000	22000
Elongation, per cent in 2 in.	3	5
Modulus of rigidity	2400000	2400000
Modulus of elasticity	6500000	6500000

NOTE: Rivets used were 56S aluminum alloy having characteristics as follows: Allowable shear, 25,000 psi; allowable bearing, 60,000 psi; all flush rivets in 0.040-in. sheet or less, dimpled; all flush rivets in 0.050-in. sheet or thicker, machine-countersunk.

Preliminary Static Test. After completion of the design and construction of the first panel, a preliminary static test was conducted in the laboratories of the University of Michigan.

[1] "Use of Magnesium in German Aircraft," by H. W. Schmidt, *Aeronautical Engineering Review*, vol. 2, June, 1943, p. 7.

[2] "Magnesium for Aircraft Construction," by E. W. Conlon, *Journal of the Aeronautical Sciences*, vol. 7, April, 1940, pp. 252–255.

[3] "Magnesium Alloys in the Aircraft Industry," by J. C. Mathes, *S.A.E. Journal*, vol. 48, 1941, Transactions Section, pp. 76–80.

TABLE 6 SUMMARY OF TESTS ON SNJ-2 WING AND COMPONENTS

Part	Type of test	Per cent of ultimate load supported	Failures and remarks
Aileron and carry-through	Down load	100	None
Retracting-strut bracket	Compression	100	Failed at 103 per cent
Retracting-strut bracket	Tension	100	None
Flap and carry-through	Up load	100	None
Aileron (first test)[a]	Up load	80	Spar buckled at inboard end
Aileron (second test)[b]	Up load	100	None
Wing	1 HAA	100	None
Aileron[a]	Up load (destruction)	167	Failed at 170 per cent
Aileron[a]	Vibration endurance	...	Satisfactorily completed
Aileron[b]	Up load	100	None
Aileron[b]	Vibration endurance	...	Failure at spot weld after 2,715,500 cycles
Aileron[c]	Up load (destruction)	147	Failed at 150 per cent
Aileron[c]	Vibration endurance	...	Satisfactorily completed; 4,000,000 cycles
Rebuilt wing	P HAA	100	None
Rebuilt wing	P LAA (attempted destruction)	108	None. Center section failed at 108 per cent
Rebuilt wing	Vibration endurance	...	Satisfactorily completed; 4,000,000 cycles.

[a] Conventional fabric-covered aileron.
[b] Spot-welded monocoque aileron.
[c] Riveted monocoque aileron.

These preliminary tests have been reported.[4] Their purpose was to obtain a preliminary check on the validity of the design, by testing to proof load ($^2/_3$ of ultimate) and determining what changes, if any, were necessary before sending the wing to the Naval Aircraft Factory for the final acceptance tests. Through the generous use of Huggenberger strain gages an accurate determination of stress distribution was obtained, and a prediction made as to what added reinforcements were necessary for the wing to take the full ultimate load. These were added and the wing submitted for acceptance.

First Static Test at Naval Aircraft Factory. The first official static test had rather interesting results due to the reinforcements added after the preliminary test. That test had shown the need for a few local reinforcements throughout the wing, but primarily, it has shown that the wing was weakest immediately outboard from the root. Consequently, several intercostal stringers were added at this location. Thus reinforced, the wing supported 97 per cent of the ultimate load but failed at the 100 per cent load in the positive high angle-of-attack condition. To thus build a wing from an entirely new material, predict added reinforcements from a test to 67 per cent, and have it fail at exactly the design load was, in itself, a rather remarkable achievement.

Although the wing might possibly have been accepted on the basis of this test, it was decided to build another one and retest it. This was done for two reasons, as follows:

1 The first wing had been built using Dowmetal Z-1 alloy extrusions, an expensive experimental alloy having a high silver content. Later work had shown that the commercial O-1 alloy could be heat-treated and aged to essentially the same properties and it was therefore desirable to get the wing accepted with this material.

2 The addition of the several intercostal stringers had resulted in an abrupt change in section properties at the first outboard rib where they were stopped off. This caused, apparently, a rather severe stress concentration so that the failure was rather complete at that location. By redesign of the rib it was possible to extend some of the stringers outboard further and avoid this condition.

A new wing was therefore built, incorporating O-1HTA alloy extrusions, in which the intercostal stringers were eliminated and the plating thickness at the root increased. This wing successfully supported ultimate loads in all test conditions and, in fact, was never destroyed in test because the airplane center section on which it was being tested failed at 108 per cent, and it was impossible to continue the test further. Along with testing the complete wing, component and auxiliary parts were also static-tested and they as well as the wing vibration-tested. A summary of thes teests is given in Table 6.

From these tests the naval-aircraft-factory report concluded that the rebuilt wing satisfactorily withstood all vibration and ultimate-load tests, and as a result thirty sets of wings were ordered for service tests. For more immediate trial five sets of flaps, five sets of fabric-covered ailerons, two sets of spot-welded monocoque ailerons, and three sets of riveted monocoque ailerons were ordered.

Flight Tests. After the static tests were satisfactorily completed, a set of the wings was installed for flight test at the Naval Aircraft Factory. The following air maneuvers were performed: (1) vertical bank; (2) loop; (3) aileron roll; (4) snap roll; (5) Immelman turn; (6) normal stall (with and without power); (7) spin (10 turns); (8) inverted-flight stall (without power); (9) ten dives.

During these tests the airplane carried a useful load of 1204 lb to maintain the gross load within 5 per cent of the maximum design load. With this load the maximum design conditions were exceeded on one dive when the flight analyzer showed that an acceleration of 5.8 g was reached. The wings satisfactorily withstood all of these tests with no failures of any kind. It was noted, however, that the paint was cracked at the edge of the flush rivets in the leading edge; probably resulting from flexing of the wing structure during the dives.

It was the test pilot's opinion that the airplane had a slightly better response to roll with the magnesium wings than with the standard panels.

Service Tests. At the present time service tests are still in progress so that a complete summary is not possible. We can, however, report that there are four locations where magnesium structures are being service-flown by the Navy: (1) Naval Aircraft Factory, Philadelphia, Pa.; (2) Anacostia, D. C.; (3) Pensacola, Fla.; (4) Corpus Christi, Texas.

Comparative Weights. As the particular purpose of this study was to design a wing lighter than the standard aluminum wing, it should be noted that the magnesium wing weighed 182.2 lb per panel as against 212.0 lb for aluminum, a saving of approximately 14 per cent. The comparative weight statements are given in Table 7.

[4] "Preliminary Static Test of the Magnesium Alloy Wing," by E. W. Conlon and J. C. Mathes, *Journal of the Aeronautical Sciences*, vol. 9, June, 1942, pp. 284–289.

Structural Efficiency. Included in the same program with the magnesium were similar panels constructed of many other materials, including stainless steel, low-carbon steel, and various types of bonded plywood. It is particularly interesting to note that the magnesium wings were the most structurally efficient of all types tested and were, in fact, the only ones to show any weight saving as compared to the standard aluminum construction. A comparison of the structural efficiency of the various wings tested is shown in Table 8.

It requires but a brief study of Table 8 to reach the conclusion that of all the materials widely mentioned for aircraft structures, magnesium holds a place among the most promising and that we will surely see all-magnesium airplanes in the postwar period.

POSTWAR APPLICATIONS

Although the development of peacetime products has, of necessity, been delayed due to wartime projects, a wide interest in this field is evidenced by the numerous inquiries received from manufacturers anxious to utilize the extreme lightweight of magnesium in their products. These proposed applications fall into four general types; (1) industrial equipment; (2) transportation; (3) consumer goods; and (4) business and professional equipment. Roughly, industrial equipment where magnesium had its widest commercial application prior to the war, accounts for 40 per cent of the inquiries, with the other three fields accounting for 20 per cent each. It is noteworthy that the use of magnesium in industrial equipment was so successful that it has prompted such a response now that magnesium is again available for such use.

Table 9, based on interest shown by outside manufacturers, illustrates the trend of thought on the utilization of magnesium and shows where one may expect to see magnesium in the postwar period.

Table 9 is not inclusive but gives some idea of what the trend of thought is at the present time by outside manufacturers, most of whom had not previously used magnesium in their products. It shows a wide and genuine interest in magnesium and, particularly in consumer goods, an increasing recognition of the steadily growing lightweight consciousness of the general public. This fact alone insures a wide market for magnesium in the postwar period, not only in industrial and commercial applications, where the lighter weight pays for itself in dollars and cents, but also in goods used by the general public where the lighter weight provides a convenience value and general utility not obtainable with any other metal.

TABLE 7 COMPARISON OF WEIGHTS OF ALUMINUM AND MAGNESIUM OUTER WING PANELS FOR THE SNJ-2 AIRPLANE

Item	Aluminum, lb	Magnesium, lb
Main beam	17.8	14.98
Auxiliary beam	3.8	3.10
Ribs	13.25	11.64
Stringers	38.6	33.25
Metal covering	78.3	57.65
Miscellaneous items	27.75	32.21
Paint	2.0	5.73
	181.50	158.56
Aileron	24.00	18.00
Flap	7.00	5.65
	212.50	182.21

TABLE 8 STRENGTH AND EFFICIENCY COMPARISONS FOR SNJ-2 (OR ARMY EQUIVALENT) OUTER WING PANELS

Material	Weight	Bending moment supported at root	Bending moment per unit weight	Structural efficiency (Al = 100 per cent)	Weight in per cent of Al
Magnesium (riveted semimonocoque)	158.6	1,265,000[a]	7980[a]	115.2[a]	87.4
Aluminum	181.5	1,255,000	6920	100	100
Stainless steel	208.0	1,375,000	6610	95.5	114.6
M4610 steel	207.9	1,135,000	5480	79.2	114.5
Magnesium (welded monocoque)	230	1,108,000	4820	69.6	126.7
Plywood	296	1,250,000	4220	61.0	163.0
Plywood	261	1,032,000	3960	57.2	143.8
Plastic plywood	293	1,087,000	3710	53.6	161.2
Plastic plywood	282	1,028,000	3650	52.7	155.5

[a] Did not fail.

TABLE 9 TYPICAL FIELDS OF APPLICATIONS FOR MAGNESIUM

Industrial Equipment	Transportation	Business and Professional Equipment	Consumer Goods
Automotive tools	Aircraft	Advertising signs	Appliances
Air conditioning		Business machines	Bicycles
Conveyers	Automobiles	Farm equipment	Furniture
Elevators	Buses	X-ray equipment	Hand tools
Excavating equipment	Outboard motors	Office equipment	Kitchenware
Portable engines	Railroad equipment	Optical equipment	Lawn mowers
Foundry equipment	Trucks	Photographic equipment	Ladders
Portable tools	Motorcycles	Printing equipment	Cameras
Hoists			Movie projectors
Textile machinery			Radios
Portable equipment			Sporting goods
Printing machinery			Toys
Oil-well equipment			
Scaffolds			

Indicated Principles of POSTWAR MACHINING

By CARL HIMMELRIGHT

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AT the outset of mass production for war (of innumerable items not theretofore machined in large quantities), it quickly became painfully apparent that, despite its mechanization, American industry relied more heavily on its highly trained craftsmen than it cared to acknowledge. In other words, our machine-tool equipment, although quite reasonably adequate for the requirements of peacetime output previously existent, was not designed to function without dependence on high skill on the part of operators.

When output was stepped up and machine units multiplied to reach war volume, there were not enough skilled operators to go around. So great was the demand for volume that even those developed by intensive training were able to give only a "lick and a promise" of their skill to each part as it passed through their particular stations on the production line.

That American industry has surmounted this problem and achieved outstanding success, not alone in high production but equally in high precision, can be attributed in all modesty to the ingenuity of its mechanical engineers. From the differences in machining practices they have of necessity instituted, there arises an indication of new principles which undoubtedly will be incorporated into accepted practice for successful postwar output.

TRENDS IN MACHINING PRACTICE

Certain machining practices have been developed by the author's company to meet war conditions, which point to trends, the formulization of which may become an inseparable part of "how to do it" successfully in the coming peacetime era.

As an instance, parts for aircraft engines exemplify the introduction into American production of more efficient use of the actual strength of materials. Many aircraft materials do not lend themselves to good machinability under practices once considered standard. Yet the finish quality of such parts is an essential factor in developing their strength-weight ratio. Furthermore, such results must be obtained in volume production, despite infinitesimal tolerances and finishes measured in microinches.

Along with the high cost in man-hours of submitting such parts for finishing on the burring bench, the buffing wheel, and the like, there is the element of human error, which results in high percentage of scrap because of the exacting accuracy required.

Tumbling Barrels. We have found that tumbling barrels, sometime referred to as "rotofinish" machines, are successful. Not only can burring be accomplished by the removal of the sharp edges and corners, all without reducing finished dimensions and risking the induction of cracks or scratches due to the danger of human element on the burr bench or buffing wheel, but an improvement of the surface finish and quality is actually achieved.

In fact, the use of the tumbling barrel makes it unnecessary to hold the exact final-inspection limit on surface quality during prior machining or grinding, since the final and desired surface finish can be induced by this method.

A battery of such barrels obviously fits into the postwar view, as compared with extensive hand labor involved in conventional burring, buffing, and similar operations. To make use of such equipment it is necessary to work out a ratio of the number of parts, the quantity and size of stone or chips, to the size of the barrel being used, and the time required to run each load to obtain the removal of sharp edges, surface finish, and the desired results with efficiency.

Thus far, by reason of the newness of this method, no "cut-and-tried" formula exists. Yet we have found that data supplied by the makers of these machines have been sufficient to guide our efforts so that the extent of "cut-and-try" experiments is held to a minimum. Once the desired results are obtained by experimentation, a sequence of operation is written for the loading of the barrel, the weight and size of stone or chips, and the time required. With this established and followed, the results will be identical and consistent.

Currently, we are obtaining surface finishes of 6 to 8 microinches, and breaking of sharp corners with a radius of 0.008 to 0.010 on aircraft-engine parts, such as gears, gear and spline shafts, bearing retainers, and the like.

Another instance of importance is the results obtained in producing gear trains that function practically without backlash. These gear trains are free-rolling, and the gears must be produced with pitch diameters held to a tolerance of 0.001 in. Runout of the pitch diameter is 0.001 in., maximum. Tooth-to-tooth spacing is held to 0.0002 in., and accumulative spacing of any teeth 0.0004 in., maximum. The advantages obtained by producing gears to such close tolerances need no emphasis. Gear trains of this class operate in both directions with insured accuracy and results.

Gears produced to such high degrees of accuracy are of no value if the gear frames or housings are not also produced to the same degree of accuracy and close tolerances. The center distances are being produced to 0.0005-in. tolerance, and the bearing bores are being held to 0.0003 and 0.0004-in. tolerances. This presents something of a difficulty when it must also be considered that in any one gear frame the bearing bores may vary from $^7/_8$-in-diam to $3^3/_4$ or 4-in-diam bore.

Jig Borers. Here we have found it practical to make an adaptation to toolroom practices, i.e., that the bearing bores on these gear frames are being bored on jig borers. In other words, we are confronted with problems similar to those of fixture and gage work raised to a production basis, since the tolerances mentioned actually are fixture and gage tolerances.

The gear housings and frames are made of steel castings and weldments. The rough material is normalized or put into a deadened state to overcome distortion and prevent variations which might result from machining.

After they have been rough-machined all over and all finish-machining except the bearing bores has been completed, the gear frames are placed in suitable holding fixtures which are mounted on the jig-borer table.

The boring operations can be accomplished with accuracy by these machines, by reason of the gaging arrangement, if the sequence is so arranged that the part need not be relocated once it is placed in the jig-borer fixture.

Contributed by the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., Nov. 27–Dec. 1, 1944, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The spindle of the jig borer is being revolved up to speeds of 1800 rpm. With speeds as high as this it is necessary to balance the boring heads in order to overcome the whip that would cause an out-of-round tapered and rough hole.

To accomplish this we use one boring head for each size of hole to be bored and keep the boring tool on center.

For smaller holes, offset boring cutters are used, and on larger holes a bar with a tool bit is used. By this type of tooling the boring head is kept in balance and the cutter or cutter bar are also in balance.

When we shift from one hole to another we change the heads, complete with cutter or cutter bar, and replace that head with a head set up for the next hole to be bored. If the holes to be bored do not vary more than $^1/_2$ in. in diam, we can adjust the boring head and not be affected by an out-of-balance condition that will affect the class of work desired.

When changing boring heads, it is necessary to take a trial cut and measure the trial-cut hole with a dial-indicator-type internal-measuring gage to determine the amount of stock to be removed to hold the final size and tolerance.

Changing heads and machining on a jig borer with the spindle running at high speeds are not toolroom practices, but are necessary in order to obtain output on a production basis and with a production setup.

Gear-Shaving Process. Another type of gear being manufactured at a high monthly production rate is one produced to exactly the same tolerances previously mentioned, except that it requires a backlash of 0.006-0.007 in. when assembled in a unit. These gears are for a planetary unit and revolve in only one direction. Close tolerances on the pitch diameter, runout, and tooth spacing are required so that all gears in the unit carry an equal amount of the power load.

These gears are being produced to the same tolerance as ground gears, but without grinding. Instead, they are shaved, the shaving taking place prior to heat-treatment. No other work, such as machining or grinding, is done on the gear teeth after the heat-treatment.

To make this possible it is necessary to develop the involute curve and decide on the pitch diameter to compensate for changes in size and metal movement resulting from heat-treatment. Generally speaking, heat-treatment causes the gear tooth to shrink in chordal thickness at the tip of the tooth and to increase in chordal thickness at the root of the tooth; at the same time the pitch diameter increases in size.

After determining experimentally the extent and direction of the heat-treatment changes on a batch of gears that have been shaved and heat-treated, the next step is to regrind the shaving cutter to compensate for the known changes and then to shave and heat-treat another batch of experimental gears. The desired involute curve then being obtained, the gear can be put on a production basis. The only requirement from this point is always to regrind the shaving cutters to the compensated shape.

To produce gears to the close tolerances mentioned, in addition to a close control on the grinding of the shaving cutters, close control must be maintained of the heat-treating operation by developing a time cycle for carburizing, annealing, and hardening. This procedure must be carried out step by step to a high degree of precision.

The considerable saving in production which this method affords as compared with the grinding of gear teeth can be demonstrated by the following example:

Consider a gear having 22 teeth, 12 diametral pitch, and $22^1/_2$-deg pressure angle modified form. To grind this gear required 15 min on a form-type gear grinder. This same gear requires only 2 min to shave. Thus a saving of 13 min machining time is made for each gear which, multiplied by the thousands required monthly, represents a great saving in manhours.

Close-Tolerance Threading. Another type of production that approximates toolroom practice is that of achieving class 4 and even class 5 tolerances in threading operations. Such requirements are beyond former needs. Yet it appears probable that the future trend will be toward threads, the tolerances for which are so close that a slight variation in hardness of the workpiece must be considered.

Between several taps, which presumably are of a given size to achieve desired results, selection must be made for size, finish, and runout, and the thread form checked on a comparator.

Even though the proper taps have been selected, there remains the necessity of using them properly in order to produce close-tolerance tapped holes.

To accomplish this there are available precision automatic tapping and threading machines which will hold class 4 and even class 5 tolerances, provided the proper selection of taps and dies is observed, together with other basic considerations.

The major item in precision threading is the use of a leader-and-follower arrangement which will control the operation and assure the correct lead. This is of the utmost importance in close-tolerance threading.

DESIGNING TOOLING AND FIXTURES FOR CLOSE-TOLERANCE WORK

The demand for exact and close-tolerance work which must be produced in large volume and by semiskilled operators necessitates the utmost care in designing the tooling and fixtures. They must be so designed that the workpiece is automatically located without involving any particular skill on the part of the operator. It must be possible to operate the fixture so that it will function without producing an error in the work. Tooling which meets these requirements does much to eliminate human error, speed up the work, and substantially improve its precision.

An example of this grade of tooling is an indexing fixture designed to grind four bearing holes in a planetary-gear case. The work part is held eccentrically in relation to the center line of the machine spindle. The rotational index member of the fixture is also located eccentrically in relation to the spindle center line. As the eccentrically located workpiece and entire fixture revolve, the bearing bore revolves concentrically with the machine spindle. In operation, one hole is finished complete, next the eccentric portion of the fixture on which the workpiece is mounted is indexed, bringing the next hole into position on the center line of the spindle. Then this hole is finish-machined. In like manner all other holes in the workpiece are indexed into position and machined.

The similarity may not at first be apparent, but such applications may be likened to the functioning principles of an automatic turret lathe.

CUTTING-TOOL DEVELOPMENTS

The cutting tool cannot be overlooked. Its development is of equal importance, and the part it will have in the postwar future must also be considered. This importance can be exemplified by the problems presented when it became necessary for us to machine engine bases for Diesel engines.

These engine bases are weldments, fabricated principally of low-carbon-steel plate. In order to obtain the required smooth, glassy, machined surfaces, we developed a cutter shape for boring, milling, and planing. The top of the cutter was set at a 45-deg angle and with a positive top rake of 12 deg. The end of the cutter was ground to a crowned shape. These cutters gave a clean shear cut, producing surfaces having such finish that watertight fits could be maintained without the use of gaskets.

Such matters as the shape and angles of cutting tools, and the speeds at which they operate, are of considerable importance in viewing postwar production possibilities. On the further development of knowledge in this direction will depend in large

(*Continued on page 479*)

Controlling MOISTURE CONTENT *in* WOOD *and* GLUED TEST SAMPLES

Inexpensive Means Developed for Block and Shear-Test Samples Used to Evaluate Water-Resistant Glues

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An inexpensive, easily constructed, constant-humidity room has been built at the Southern Regional Research Laboratory[1] for controlling the moisture content of the wood and glued samples used in the block and plywood shear tests. The humidity control has been accomplished by taking advantage of the fact that a saturated calcium-chloride solution will maintain a relative humidity of 31 to 33 per cent at ordinary room temperatures.[2] Under these humidity conditions wood reaches an equilibrium moisture content of about 6.5 per cent on an oven-dry basis.

It has been reported by various workers in this field that they have experienced considerable difficulty in maintaining constant humidity in rooms by passing air over saturated salt solutions. Such a system is considered to be satisfactory only in a well-enclosed cabinet of small size in which a relatively small volume of material is stored under conditions in which the samples can be inserted and removed with minimum disturbance to the conditions in the chamber. However, by the use of a special basket for holding the flake calcium chloride and by storing considerable amounts of dry wood in the room (about 200 lb), satisfactory humidity control has been obtained with the equipment to be described.

The plywood and block shear tests for evaluating woodworking glues were developed by the U. S. Forest Products Laboratory. References relating to the development of these methods for evaluating the water-resistant casein-type glues and to their use in various Government specifications and in gluing manuals, are listed chronologically in Table 1. The table also gives information on the specified conditions of temperature and relative humidity. A moisture content of 6.5 to 7 per cent is acceptable for both plywood and block shear tests when testing water-resistant casein and casein-type glues. Government specifications and gluing manuals are not mandatory with regard to specific seasoning conditions for the glued joints, but generally require that the wood used to prepare the test samples shall be dried to a given moisture content. It is believed that the high cost of dehumidification by means of refrigeration has prevented more uniform moisture control of the glued test pieces.

Water-resistant glues of the casein type are ordinarily employed for making plywood designed for interior use. For this purpose it is desirable to glue wood having a moisture content corresponding to that which would be attained under subsequent conditions of use. Because of this, and because a considerable amount of water is added to the veneer when it is glued with an adhesive in water solution, the test conditions

TABLE 1 SPECIFIED TEMPERATURE AND HUMIDITY CONDITIONS FOR EVALUATING GLUE BY PLYWOOD AND BLOCK SHEAR TESTS

	Block shear test		Plywood shear test		
No.	Maple wood	Glued blocks	Birch veneer	Glued plywood	References
1	Moisture content 7 per cent	Seven days conditioning at room temperature	Condition to same moisture content.....not higher than 12 nor lower than 7 per cent	Condition to same moisture content veneer had before gluing	"Gluing Wood in Aircraft Manufacture," by T. R. Truax, U. S. Department of Agriculture, Technical Bulletin No. 205, 1930, pp. 11 and 12
2	Moisture content not to exceed 10 per cent	....	Moisture content not to exceed 10 per cent	Dry in air 72 hours	U. S. Army Specification No. 3-152A. Sept. 30, 1931. (Superseded by Spec. C-G-456.)
3	....	....	30 per cent R. H.; moisture content of about 6.5 per cent	Bring to equilibrium at 30 per cent R. H.	"Serviceability of Glue Joints," by Don Brouse, Mechanical Engineering, vol. 60, 1938, p. 306
4	Moisture content shall not exceed 10 per cent	Six days at room temperature	Moisture content shall not exceed 10 per cent	Dry in air for 72 hr	Navy Specification 52G8c, May 1, 1941, Glue, Casein, Water-Resistant
5	Moisture content not more than 10 per cent	Six days at 70 to 80 F, and R. H.[a] of 45 to 55 per cent	Moisture content shall not exceed 10 per cent	72 hr at 70 to 80 F, and R. H. of 45 to 50 per cent	Federal Specification C-G-456, July 8, 1941, Glue Casein-Type, Water-Resistant
6	Moisture content of about 7 per cent	Six days at room temperature	Moisture content of about 7 per cent	Three days at room temperature	"Manual for the Inspection of Aircraft Wood and Glue for the United States Navy," second edition, 1941, pp. 68–71. (Testing Casein Glue.)

[a] R. H. = relative humidity.

[1] This is one of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

[2] "Handbook of Chemistry," by N. A. Lange, fourth edition, Handbook Publishers, Inc., Sandusky, Ohio, 1941.

Contributed by the Wood Industries Division of The American Society of Mechanical Engineers.

obtained with a relative humidity of 30 per cent are considered satisfactory. However, most wood in exterior use has a moisture content of 12 per cent, or higher. For purposes of evaluating waterproof glues for exterior use the optimum moisture content for making joints would be higher than for interior use, and exposure to a relative humidity of 65 per cent is ordinarily considered satisfactory.

Relatively close humidity control is essential for the work being conducted at the Southern Regional Research Laboratory on the development and improvement of plywood glues from peanut and cottonseed meals, and from proteins derived from these meals. Since the temperatures prevailing in the laboratory vary but little from 80 F, temperature control is no problem. Other laboratories should have little difficulty in locating a conditioning room where the maximum temperature variation is between 75 and 85 F. A deviation of ±5 deg from 80 F appears to have no significant effect on the humidity of the conditioning room or on the glued joints.

DESCRIPTION OF CONDITIONING ROOM

The room illustrated in Fig. 1 is constructed with a wooden framework of 2-in. × 2-in. strips. The exterior of this framework is covered with $^1/_8$-in. Masonite board and the interior is lined with 26-gage galvanized sheet metal which is soldered at the joints. The interior dimensions of the room are 9 ft × 6.5 ft × 7 ft high. It has a narrow tight-fitting door. The air in the room is circulated by means of an electric fan. A hygrothermograph is used to record the temperature and relative humidity. The temperature of the conditioning room approximates 80 F, and the relative humidity varies between 31 and 33 per cent. Under these conditions, the wood and glued samples attain equilibrium with approximately 6.5 per cent moisture calculated on an oven-dry basis.

The relative humidity of the room is controlled by means of flaked calcium chloride contained in a Solvay "Air Dryette" which consists of a triple V-shaped wire basket supported on the edges of a glass dish. The saturated calcium-chloride solution drips from the flakes in the basket container and is caught in the glass dish. In this way the wet surface of the flakes continuously presents a large area of saturated solution for maintaining moisture equilibrium in the room. It is also quite probable that the dried wood stock stored in the room serves as a buffer in absorbing or gradually releasing moisture. These two factors are believed to be responsible for the successful operation of the conditioning room.

When the room is used in this way for storing an appreciable volume of wood, it is necessary to predry the stock to 6 to 7 per cent moisture before placing it in the conditioning room.

The calcium-chloride container shown in Fig. 1 holds approximately 10 lb of the flakes which will absorb, according to the manufacturer, from 10 to 30 lb of moisture. A larger basket holding 30 lb of calcium-chloride flakes is available for use in rooms of larger size. The number and size of the baskets and fans required will of course depend on the amount of moisture to be removed and the size of the room. The equipment described has proved to be adequate for conditioning 10 to 20 glued-plywood test panels (4 in. × 12 in.) and 6 or 8 glued test blocks ($2^1/_2$ in. × 12 in.) per day, and probably would be satisfactory for larger numbers of test samples.

CONCLUSION

The conditioning room described is a practical and inexpensive means of obtaining standard equilibrium moisture content of plywood and block shear-test pieces and makes it possible to test glue joints made with water-resistant glues under standardized and reproducible moisture conditions.

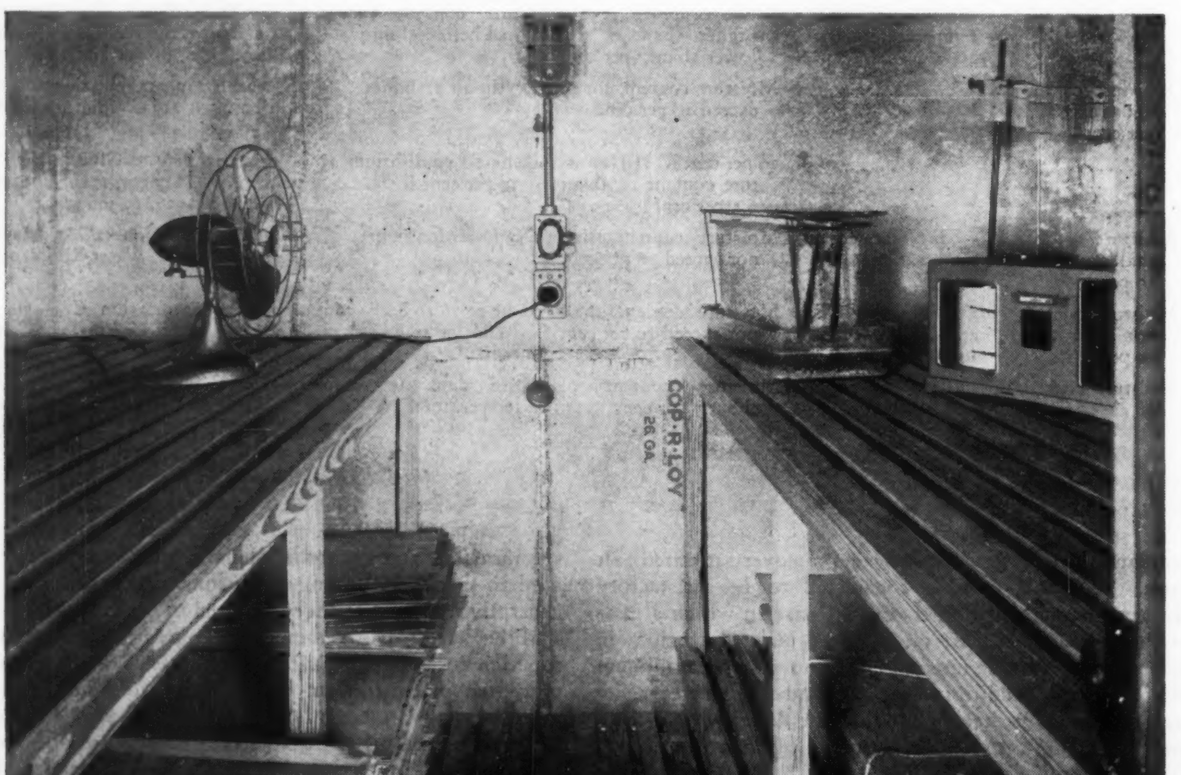


FIG. 1 CONSTANT-HUMIDITY WOOD-SEASONING ROOM

A Survey of

CO-OPERATIVE COUNCILS

By FRANK SANFORD

PAST PRESIDENT, CINCINNATI COUNCIL

FORMATION of local councils of engineering, technical, architectural, and scientific societies is a movement that is rapidly gaining strength across the country. Provision of a medium for co-operative action among local sections of national societies and local clubs or societies of engineers is the principal purpose of these council organizations. New individual memberships are not involved, but members of all consituent groups are members of the council through affiliation of their organization.

Local conditions and purposes have governed the arrangements made, and in general there has been no outline or guidance on a national scale. Local committees planning councils have often sought some suggestions from a few other cities but, in so far as we have been able to learn, no general review has been made of the various arrangements in use. The Cincinnati Council has sponsored this survey of co-operative plans in other cities, in recognition of its own tenth year of operation.

Our broad purpose is to make available to other similar groups the suggestions and encouragement that such a review may bring as well as to seek possible ideas for extensions or improvements in our own plan. Knowledge of the plans and experiences of others may be helpful to those who are starting and experimenting. It may also be an inspiration to still other groups to start or to expand co-operative arrangements.

SCOPE OF ORGANIZATIONS

Information from 35 local organizations has been reviewed in this survey. About 400 local sections and societies and 100,000 individual members are represented in the councils or affiliate arrangements.

Four of these co-operative council plans have been in operation 25 years or more. Six more were added by 1930, eleven in the period 1934 to 1939, and ten since 1940. Of the latter, five councils were started last year. Four additional councils are now being organized.

Since the primary purpose of this report is to present ideas that may be helpful and suggestive, some of the outstanding activities have been noted rather than details of each council. A tabulation of size, of member organizations, and of other data was prepared, but it does not appear as useful as the more pertinent information derived from a review on this broader basis.

Two "founder" societies, A.I.E.E. and A.S.M.E., are in every council of the survey, with a third, A.S.C.E., missing in only five cases. A professional engineers' society, most frequently a chapter of N.S.P.E., is listed in two thirds of the reports. Architects are represented about one half, and A.S.M., A.S.T.E., A.W.S., A.S.H.V.E., A.C.S., A.I.C.E., I.R.E., I.E.S., A.F.A., and A.I.M.E. appear in smaller numbers. This latter group and some others are included in the larger cities or larger industrial centers, apparently wherever there are local sections.

Excepting in four cities, the average council includes ten member societies—four with 15 to 17 members, four with 5 or 6, and the majority with 8 to 12 societies. Cleveland and Chicago with 33 societies, Detroit with 28, and Pittsburgh with 25 cover a much broader scope of organization than this average.

OUTLINE OF PURPOSES

Co-operative action by the member societies on matters which are beyond the scope of the individual organizations is the primary purpose stated. A means is provided on a broad scale to promote the public welfare whenever technical, engineering, and scientific knowledge and experience are involved or can be useful.

Another definition states, "for co-operative effort in increasing the scope and availability of the individual organizations; to promote, co-ordinate, and integrate interorganization activities and good will; to publish a bulletin; to encourage interest and participation in civic affairs."

Provisions are made for: Vocational guidance for technical students, co-ordination of program activities, encouragement of joint meetings between two or more societies. Annual joint meetings of all societies are arranged by several councils. Co-ordination is a stated purpose, but there is no direct jurisdiction over the meetings or actions of the constituent societies.

Several councils have been organized in connection with, or as a result of, war activities. Two council reports state that "the organization is a natural development from the organization of societies which sponsored the War Production Clinic."

Another followed a temporary arrangement to consider post-war planning problems. It was felt desirable that the engineers be represented in future action and be organized to offer their assistance and advice in the solution of such problems.

PLANS OF ORGANIZATION

In all of the council plans reviewed, the affairs are administered by two representatives or delegates, or by one delegate and an alternate, from each society. They are usually regular officers of the member society or, in a few cases, they are appointed for the council. Meetings of the council, governing committee, or board are held three or four times each year, or annually and as called by the chairman.

Perhaps the organization plans can be classified into three broad groups or types, although the lines of separation in type are not sharp.

(1) A local engineers' club or society sponsors local-section affiliation or participation in a council. Joint memberships are encouraged by several local societies, by a reduction in dues for members of affiliated societies.

(2) Local sections have organized the council, usually with a local club participating as one of the members.

(3) A combination of the two plans appears in a few cases, including the Cincinnati Council. The local society and local sections of national societies are members of the council, with the local society performing certain services for the council.

Reprinted from *The Engineers and Scientist*, official publication of the Technical and Scientific Societies Council of Cincinnati, April 16, 1945.

NOTES OF ACTIVITIES

The following notes of activities may not do justice to many of the councils. The aim has been to select an outstanding point about each, and in this I could easily be in error because of lack of familiarity with the individual group.

Since 1916, The Engineers' Club of Baltimore has sponsored a plan of affiliation, providing local headquarters, meeting rooms, and services for which each society pays annual dues for its members who are not also members of the Club. A closely knit association has resulted for interest in civic and technical matters in the city.

Joint Council of the Associated Engineering Societies of St. Louis is composed of representatives from the Engineers' Club of St. Louis and from each local section of a national engineering society holding membership in the Council. Joint Council has, since 1914, taken an active interest in civic affairs such as furnishing aggressive assistance in the formation and adoption of a new smoke ordinance, framing examinations for civil service, writing a new building code, and in recommending appointments to prominent technical positions. They do not have a publication or joint notice for societies' meetings.

Affiliated Technical Societies of Boston, organized in 1922, has grown from 9 to 15 affiliated societies and is now organized as the Engineering Societies of New England. Co-operating also are 8 allied organizations in other cities. An outstanding activity is industrial co-operation with various manufacturers' associations and chambers of commerce in the area. Other committees are to provide counsel and assistance for young engineers, for public affairs, and for employment service. Outstanding engineers are recognized by an annual New England Award. A weekly paper carries notices of all affiliated society meetings.

A record of civic and professional affairs interest that seems to be unsurpassed by any other council appears in the reports of the Connecticut Technical Council (New Haven). The state engineering registration board, appointed by the Governor, is largely from the recommendations of Council. Several other commissions and board appointments where engineering qualifications are desirable are similarly made from lists submitted by the Council. Programs of vocational guidance, civic planning, and co-operation with war-industry conferences have received active attention. Publication of a bulletin has recently been started, with distribution to members of all societies.

The Florida Engineering Council has representatives of the Florida Engineering Society and of local sections and local organizations to act as a co-ordinating committee for all engineers and for engineering problems of the state.

Four local engineers' clubs, two state associations, and three local sections of national societies co-operate in the Minnesota Federation of Engineering Societies. This state-wide organization, with headquarters in St. Paul, has taken an active interest in bond issues and codes, and in submitting lists of qualified members to state boards.

The Worcester Engineering Society is made up of six affiliated societies, who have voted their entire membership into the Society. By such action, the affiliate "shall not forfeit its own individual identity and it shall continue to follow its own methods of action. . . ." Individual memberships are also provided in the Society for those who are not members of an affiliated society.

Local sections of four national technical societies are affiliated with the Rochester Engineering Society. The clubrooms are furnished for meetings, and secretarial and office services are provided for business affairs of all societies. The *Rochester Engineer* is sent monthly to all members of the societies, and the cost for all services is on a per member basis.

A somewhat similar plan is followed by the Providence Engineering Society. Each technical organization may hold its meeting in the Society's auditorium, and a weekly meeting announcement bulletin is sent to all members of all affiliated societies. The chairman of each local section meets with the Engineering Society Council.

The Engineers' Club of Birmingham furnishes office service for technical societies in the Engineering Council. Separate notices of society meetings are mailed by the Club office. The chairman of Engineering Council serves on the board of the Club.

Organized in 1943, The Chicago Technical Societies Council would seem to have undisputed place as the largest organization of this kind. It grew from a temporary committee to assist in the WPB War Production Clinic, and it now has 33 societies with 16,000 members. A monthly calendar of all meetings is sent to all members.

The Cleveland Technical Societies Council publishes *Cleveland Engineering* for its 33 member societies. This weekly was formerly the publication of The Cleveland Engineering Society, which is a member of Council. It carries notices of all meetings to 10,000 individual members of the societies.

* * * *

Annual joint meetings of all the member societies are important features of several councils, and other joint meetings of two or more societies are frequently arranged in most councils.

Seven joint or general meetings were held in the past year by the Schenectady Engineering Council. This group also has committees active in technical and vocational education and community planning.

Colorado Engineering Council (Denver) celebrated its 25th anniversary at its annual reunion in December, 1944. A committee is now preparing a history and review of its activities.

Three joint general meetings, each sponsored by a member society, are a feature of The Toledo Technical Council. At a recent Council general meeting there were 600 engineers and architects present of a combined membership of 900. A novel arrangement is the publication in a local newspaper of a column of Council Society news and notices.

An annual dinner meeting of Oregon Technical Council (Portland) was discontinued during the war. Plans of the Affiliated Engineering and Allied Societies in Ontario (Toronto) to hold an annual joint meeting of all societies were delayed by the war.

Ten annual joint general meetings with speakers of national prominence have marked the years of the Cincinnati Council. A weekly publication serves as a medium for announcing programs to all of the individual members of societies in Council and an annual directory lists all committees and a roster of members. The Engineering Society is publishing agent and maintains the membership and financial records.

Three cities in Indiana have Councils. Co-operation of three local sections in several activities led to formation of The Engineers' Club of the St. Joseph Valley in South Bend. They are active in postwar planning, in an airport location, and are now planning an industrial exhibit. A monthly magazine goes to all members of the co-operating societies. Local sections of four societies co-operate with the Ft. Wayne Engineers' Club in a Civic Affairs Committee. Their *Engineers' News* is one of the best papers sent to me in this survey. Co-ordination and secretarial services for the Indianapolis Technical Societies Council are furnished by the Chamber of Commerce Industrial Branch. A monthly bulletin to be sent to all members is planned by this newly organized group.

Several large industrial centers have similar local society affiliation arrangements to facilitate co-operation in matters of common interest. The Engineering Society of Detroit and the Engineers' Society of Western Pennsylvania in Pittsburgh each publish a calendar of affiliated-technical-society meetings and have arrangements for use of their auditoriums by these societies.

In Philadelphia, the Engineers' Club co-operates with local sections through an Affiliated Societies Council. The Engi-

neers' Society of Milwaukee has plans for greatly expanding its own activities and is working toward a closer affiliation arrangement with other local societies.

The weekly publication of the Technical Club of Dallas carries all meeting notices to members of local sections affiliated with the club. Each society pays the cost of mailing for its members.

Local sections in San Francisco have an Engineering Council, with many features similar to the arrangements in Cincinnati. The District of Columbia Council is not as actively organized but they are ready to report on any question referred to it by a member organization. A joint notice bulletin was formerly published, but was discontinued several years ago.

The *Louisville Engineer and Scientist* was started on its publication schedule in December, 1944. Ten member societies comprise the original group in the Council. The start they have made should be an inspiration to every similar group.

Two other widely separated groups are at similar stages of Council development. The Puget Sound Council in Seattle and the Columbus Technical Council are aiming toward cooperative action. Columbus expects to start its publication in May.

A committee representing nine societies is planning for a reorganization of the Engineering Foundation of Buffalo to be more along lines of other council arrangements. A council is being organized in Kansas City. A monthly calendar sheet is to be sent with regular meeting notices of member societies until a bulletin can be arranged. The Engineer's Club of Tulsa is planning an affiliated council and expects that this review may be an added incentive in its efforts.

A constitution is ready for adoption by the local sections and the Engineers Club of Dayton. This is along lines of the Cleveland and Cincinnati plans. A joint publication is expected as an early activity.

PUBLICATIONS

Publication of a monthly or weekly bulletin or magazine is one of the most desirable regular activities of a council. Regardless of the extent of other aims and objectives, it is essential that news and information of local interest to engineers should be carried to all the members in the local societies.

Monthly publications are used in a majority of the cases reviewed. A calendar of meeting and program announcements may be included, but apparently this medium is not as widely used as it might be. One or two reports noted that notices were sent out to their members by the individual societies in addition to the notice in the publication.

Weekly publications, as in Cleveland, Cincinnati, Providence, and some others, serve for the meeting notices. In a number of the cities, the council publication is sent only to officers who are interested in co-ordinating activities; but interest in a general paper is indicated by several reports where this is now the practice.

Advertising is included in about half the publications received in this survey. This is notably true in Chicago, Cleveland, and Schenectady, where it is stated that the council has no publication expense. Louisville expects to reach a self-sustaining basis also. Costs per member for other publications are noted at 40 or 50 cents per year for both weekly papers and the larger monthly magazines. These subscriptions are apparently always paid by the local section as its cost in the council.

In this connection, it should be noted that there is no better advertising medium to reach the engineers, architects, and specification writers of a local area than that afforded by a small local-interest publication. Equipment, tools, supplies, materials, and services are being requisitioned or purchased daily by a large percentage of engineering-publication readers.

ACKNOWLEDGMENT

This very brief review is based on much more complete information received from the chairman or secretary of each group, and it was possible only because of their interest and help. To them we extend thanks and best wishes.

The national boards of societies co-operating in the Engineers Council for Professional Development have endorsed proposals for joint activity of local units. The E.C.P.D. pamphlet "Will You Help?" points to a future possibility for broader co-operation. They clearly recognize that further development for joint action depends on local growth, and we hope that this survey may be helpful to them.

Locating the right men to furnish the desired information proved rather difficult in some cities. Thanks for help in this direction are due Charles Lee and P. L. Alger and several local-section secretaries of A.I.E.E.

I will be glad to furnish more details from the information I have, or to forward requests for further information. This exchange may prove of considerable benefit in expansion of activities and for co-operation among the local co-operative groups. (Address inquiries to Frank Sanford, The Engineering Society of Cincinnati, McMillan at Woodburn, Cincinnati 6, Ohio.)

Indicated Principles of Postwar Machining

(*Continued from page 474*)

measure the quality, precision, high output, and low cost it is hoped to achieve in peacetime competition.

Time and cost savings to be expected from finishing before heat-treatment become of particular importance because heat-treatment is an increasing "must" on the postwar list of production practices.

Heat-treatment achieves greater efficiency from basic materials by providing the surface quality necessary to get a high strength - weight ratio in the finished part.

CONCLUSION

With the further development of cutting tools, the possibilities of high-precision machining in postwar production are greatly increased. The desirability of arriving at exact final dimensions prior to inducing required hardness and surface quality demands that fixtures, cutting tools, and machine tools, be designed with the realization that high precision makes for high production.

Consideration also must be given to the power requirements of cutting tools if advantage is to be taken of advances in cutting technique. The trend is broadly indicated by cam, hydraulic, and electrically controlled machines which already are in existence. Each of these developments has contributed to improvements in machining practice.

The impact of war production the country over has been such that the burden of future high-precision volume production can be successfully carried only with equipment designed to meet specific and rigid requirements. In other words, the former reliance on the skill of operators in achieving high-precision results must be assumed as functions of the tooling and by the machine tool itself.

A POLICY FOR FULL EMPLOYMENT[1]

By ROBERT L. BISHOP

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SIR WILLIAM BEVERIDGE is no newcomer to the study of unemployment, and the personal evolution of his thought on the subject is of the greatest interest. His first major work, published in 1909, was called "Unemployment: A Problem of Industry." In his most recent contribution, "Full Employment in a Free Society,"[2] there is no mistaking that unemployment has become a problem of government.

"In 1909," says Beveridge, "I assumed, in accord with all academic economists and most practical men, that, apart from the trade cycle, demand would look after itself." Since then, new experience and a new way of looking at the facts, both old and new, have changed Beveridge's mind. He still calls for a better organized mobility of labor and measures to reduce the idle manpower reserves associated with "casual" employment, as he did earlier; but, in addition, he is now convinced that our first need is for a volume of spending that will make continuing full employment possible. Adequate outlay *may* be generated automatically by unaided private enterprise. It can be *guaranteed* only by government.

"Full employment" is easier named than defined. Beveridge's definition is by no means free of ambiguity, but it is clear enough. It implies more vacant jobs than job-seekers. This means that it would be somewhat easier to find a job than to fill one. There would be a "sellers' market" for labor, as in wartime—rather than a buyers' market, as is usual under the conditions of peace. There would always be some margin of unemployment, because of technical progress and shifts of demand; but the essence of full employment is that no one need fear prolonged idleness. Beveridge has extraordinarily little to say about the problem of the "unemployables"—and this is a regrettable omission—but the problem itself might prove to be far less serious than some would anticipate, if Beveridge's conditions were fulfilled. Full employment by his estimate would mean an ever-changing pool of workers who are between jobs, amounting to about three per cent of the labor force. This is low by comparison with the analogous estimates of other economists; but it does not reflect simply optimism on Beveridge's part, since he prescribes considerably more than a minimum governmental program for the support of employment.

The facts which Beveridge cites make it clear that unemployment has become the major economic problem of the capitalist democracies. In his own country between the two wars, the percentage of the labor force unemployed "ranged from a minimum of just under ten to a maximum of just over twenty-two and averaged 14.2." Before the first war, by contrast, unemployment had fluctuated for the most part between two and eight per cent, although these figures may be slightly too low. Beveridge is also interested in the experience of the United States, not just for the benefit of his American readers but also because the economic relations between his nation and ours will be considerably affected by the relative success of the two countries in attaining satisfactory levels of income. The American unemployment record is not so clear as the British except in rough outline. We fared considerably better than they until 1930, and rather worse during the next decade.

Both in his own thinking and in his exposition, Beveridge relies heavily on the contrasting employment records of war and peace. "The repeated experience of war is that unemployment disappears." In peacetime a comparable efficiency in the utilization of our human and natural resources is rarely, if ever, attained. In material terms this means that income which our people are able and eager to produce is irretrievably lost. In the United States since 1930 this loss, by conservative estimate, amounted to several hundred billion dollars—a figure comparable to the cost of the war. No less important are the psychological, political, and moral implications of the contrast between full employment in war and unemployment in peace.

Beveridge's recommendations for policy are also influenced by the contrast of war and peace. "The economic problem is that of doing deliberately in peace that which we are forced to do in war—of creating a community in which men and women have value." It is important to realize just what it is about war that abolishes unemployment. The essential stimulus is the greatly increased spending. This happens to come directly from the government in wartime, but a different and equally effective method might be chosen in time of peace.

Beveridge sketches three alternative routes to full employment; and he illustrates these quantitatively in terms of the British national income for 1938, a year when actual outlay was inadequate. The first route involves increased public spending but no increase in tax rates; the second, a still greater increase in government expenditure, accompanied by increased taxation to balance the budget; the third, unchanged government spending but increased private spending in response to tax reductions. The second and third alternatives represent the extremes. The former is financially conservative, but it implies a maximum of government-furnished employment. The latter implies the greatest budget deficit, but is otherwise conservative in checking the expansion of the governmental sphere of the economy.

For the United States there is much to be said for this alternative—a flexible tax policy. When total outlay threatens to be excessive, tax increases would prevent the incipient inflation. When outlay is deficient, tax reductions would allow the appropriate increase of expenditure that would stave off depression and unemployment. Throughout, government expenditure could be confined to projects chosen for their own sake; and for the rest the direction of employment would be privately determined.

The stumbling block, in the minds of many people, is that such a policy might involve an upward trend in the government debt. On this point Beveridge contributes observations that should be reassuring. In the light of increasing productivity and a decreasing interest rate, the debt in both the United States and England could be increased at a truly surprising rate without requiring an increase of tax rates to meet its charges. Even from a purely financial point of view, an increasing debt that promotes a higher level of employment would be less burdensome than a declining one that is secured at the cost of unemployment and a low national income. It is hard to escape Beveridge's conclusion: "To submit to unemployment or slums or want, to let children go hungry and the sick untended, for fear of increasing the internal debt, is to lose all sense of relative values."

For England over the next twenty years, Beveridge does not favor a policy of simply stimulating private expenditure. In

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Full Employment in a Free Society," by William H. Beveridge, W. W. Norton & Company, New York, N. Y., 1945.

the spirit of his report of 1942, the "Beveridge Plan," he prefers a direct assault by the state on what he calls "the giant social evils" of Want, Disease, Ignorance, and Squalor. He is quite explicit that his own proposals are not the only ones that would remove the threat of mass unemployment; and it is for this reason that his discussion of the "alternative routes" may have a greater interest, especially for American readers. Similarly, the detailed governmental interventions in the private economy, which Beveridge recommends, may be accepted or rejected without prejudice to his minimum requirements for a high level of employment. In this category, for example, is his scheme for governmental control of the location of industry.

The major difficulty inherent in a full-employment policy is the danger that prices and wages may be increased before employment has been brought to a satisfactory level. That is, an expanded outlay has two alternative effects: It may increase employment or it may be dissipated in price rises. In deep depression this is not a problem, but as unemployment is brought down to successively lower percentages there is a gradually increasing pressure for prices to rise. Beveridge recognizes this, but it is doubtful whether he attributes to the problem its proper weight. In the main, he appeals to the self-restraint of those who have the determination of prices and wages within their power, although he would also provide some direct control over the prices of necessities.

Here there is a real dilemma. It is doubtful whether a partial regulation of prices would be permanently effective; and the difficulties with a thorough peacetime control of wages and prices are disquieting, to say the least. The worst unemployment can probably be eliminated without difficulty; but, otherwise, our approach to "full employment in a free society" will indeed be limited by the willingness of business to enjoy expanded output without higher prices and by the willingness of labor to enjoy increased employment without demanding wage rates inconsistent with stable prices.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Builders of The Bridge

THE BUILDERS OF THE BRIDGE—THE STORY OF JOHN ROEBLING AND HIS SON. By D. B. Steinman. Harcourt, Brace & Co., New York, N. Y., 1945. Cloth, $5^1/_4 \times 8$ in., 457 pp., illus., $3.50.

REVIEWED BY LESLIE G. HOLLERAN[1]

DR. STEINMAN'S book is an eloquent refutation of the idea, often advanced, that engineers' writings are so filled with facts, figures, and formulas that they are difficult and dry reading.

This book is crammed with facts and figures, but they are so cleverly interwoven in the dramatic story of the lives of three generations of Roeblings that they never tire the reader nor divert his attention from the main themes.

Starting with the Roebling family of Mühlhausen, Germany, at the beginning of the nineteenth century, Dr. Steinman traces the family history down almost to the present day.

John A. Roebling, the strong personality of the book, was born at Mühlhausen in 1806 during the Napoleonic regime in France and grew to manhood in the aftermath of the French Revolution. Liberal thought was rampant throughout Europe. The teachings of Rousseau and Voltaire were widely read. Roebling was a student and intimate of the German philosopher Hegel. The times and the teachings had a profound effect upon Roebling which undoubtedly showed in the originality and scope of his thinking throughout his life. An ambitious mother made it possible for him to have a technical education, but when he entered the German governmental service as an engineer he found there was no place in the bureaucracy of the time for the original ideas with which his mind was teeming. He quit and came to America. After a few years as a leader in an agricultural colony at Saxonburg, Pa., he resumed engineering practice, made surveys for canals and railroads, and began at Saxonburg the manufacture of wire rope which at first was used principally for moving canal boats on inclines over mountains where the use of canal locks was impracticable.

Dr. Steinman's book details the increasing use of wire rope in various structures, including several suspension aqueducts, designed by Roebling until finally he received the contract for an eight-span suspension bridge over the Monongahela River at Pittsburgh to replace a wooden bridge destroyed by fire. Roebling's knowledge of proper design, and his application of original ideas for stiffening the structure against wind action and other stresses and strains made the bridge an unqualified success, and Roebling was thereafter recognized as the leading designer of suspension bridges in this country.

Dr. Steinman traces the development of wire-rope manufacture and the spinning and winding of cables in bridge construction and gives a detailed account of the design and construction of the great bridges which followed that at Pittsburgh—the Niagara railroad bridge, the Pittsburgh-Allegheny bridge, the Ohio River bridge at Cincinnati, and the Brooklyn bridge. These accounts are filled with dramatic episodes. With rare skill Dr. Steinman is able to bring the reader into such intimate contact with the events described that he has a feeling of being a participant.

In 1867 John A. Roebling sold the idea of a suspension span to the New York Bridge Company, a private corporation authorized by the New York State Legislature, to construct a bridge over the East River from New York to Brooklyn and was retained as chief engineer. After the design of the bridge had taken shape and during the course of surveys for its location, Roebling received an injury from which he died on July 22, 1869.

John A. Roebling was a living examplar of the American tradition of the immigrant boy who was able to rise to fame and fortune under our form of free enterprise. Such a rise does not come of itself without effort. In his case, as always, it was the result of the interaction of character, originality, native ability, and hard work.

Dr. Steinman has the ability not only to spread before his readers the deeds of his characters, but through quotations from correspondence and through penetrating comments on their actions he also makes his readers intimately acquainted with the personalities described.

After John A. Roebling's death, his very able son, Col. Washington Roebling, who had been associated with his father on other projects, took over the work as chief engineer of the Brooklyn bridge.

[1] Consulting Engineer, New York, N. Y.

Colonel Roebling suffered from an attack of caisson disease and was so disabled that he had to design the details and supervise construction from his home on the Brooklyn Heights from which he could watch the progress on the bridge.

Dr. Steinman describes in absorbing detail the trials and troubles inherent in such an unprecedented undertaking which Colonel Roebling brought to a triumphant conclusion with the opening of the bridge on May 24, 1883, sixteen years almost to a day after the appointment of his father as chief engineer.

The book portrays the character and achievements of two others sons of John A. Roebling and describes the growth of the John A. Roebling and Sons wire-rope plant at Trenton and afterward at Roebling, N. J.

By reason of the vividness of its dramatic detail and its masterly and sensitive portrayal of character, this book will have an appeal to all lovers of good biography and will have an especial appeal to engineers.

Principles of Firearms

PRINCIPLES OF FIREARMS. By Charles E. Balleisen. John Wiley & Sons, Inc., New York, N. Y., 1945. Cloth, $5^1/_4 \times 8^1/_4$ in., 146 pp., 55 Figs., $2.50.

REVIEWED BY MELVIN M. JOHNSON, JR.[1]

MAJOR Balleisen, a professional ordnance engineer for some years connected with the Ordnance Department and currently on active duty in charge of the Machine Gun Section, Small Arms Development Branch, Technical Staff, has made an important contribution to American arms literature in this book which should be specially welcomed by all students of automatic firearms.

"Principles of Firearms" is perhaps the first and only American textbook dealing exclusively with the fundamental mechanical principles of automatic gun mechanisms from the purely engineering point of view. In his preface the author states his purpose "to expound the concept that an automatic firearm is a piece of machinery operating in accordance with well-known laws of physics and hence capable of being analyzed and designed in accordance with common engineering practice."

Elsewhere, on page 127, the author writes: ". . an automatic weapon produces an irregular series of impact blows . . . . caused when the elements of the mechanism react against the receiver of the gun." The fact is that automatic guns in many aspects impose some strain upon well-known laws of physics, more especially upon "common" engineering practice. An automatic gun is virtually a whole bundle of impacts, vibrations, and rebounds, all irregular. Wisely, therefore, Major Balleisen has effectively concentrated upon principles of design.

Unfortunately, in the much-sought interludes of peace most of our engineering talent has been directed toward fields other than ordnance. During World War II our efforts have been suddenly forced into armament.

In this compact volume, brief and to the point, Major Balleisen has included sufficient introductory material to guide the uninitiated engineer, as well as to assist the professional ordnance student.

Specifically, the author discusses gun barrels, recoil, the various functions of an automatic weapon, operating systems, and five sample types of automatic arms including the M3 submachine gun, Browning machine gun, German MG151 20-mm aircraft gun, Type 99 Japanese LMG, and the Hispano-Suiza.

He further describes firing mechanisms, feed systems, sights, problems of design, methods of testing, exterior ballistics, and gun mounts.

Anyone interested in firearms will want this learned, well-written, clear, and concise volume for general information and ready reference. The full bibliographies at the end of each chapter are also very valuable. Major Balleisen merits the grateful commendation of all students of modern firearms.

[1] Johnson Automatics, Inc., Boston, Mass.

Books Received in Library

ARC WELDING ENGINEERING AND PRODUCTION CONTROL. By W. J. Brooking. McGraw-Hill Book Co., Inc., 1944. Cloth, $5^1/_4 \times 8^1/_2$ in., 347 pp., illus., diagrams, charts, tables, $4. This manual covers the arc-welding process as applied in manufacturing and fabrication, based largely on typical industrial experience. It discusses the significance of materials, fixtures, engineering control, process planning and organization, and shows how to analyze these and other factors as a basis for the effective application of arc welding to specific manufacturing problems. A final chapter gives sources of infomation on welding problems.

A.S.T.M. STANDARDS 1944 including Tentative Standards (a Triennial Publication). Part 1. Metals. 2047 pp. Part 2. Nonmetallic Materials—Constructional, 1649 pp. Part 3. Nonmetallic Materials—General. 2202 pp. American Society for Testing Materials, Philadelphia, Pa., 1944–1945. Cloth, $6 \times 9^1/_4$ in., illus., diagrams, charts, tables, $10 per volume. This new edition of A.S.T.M. Standards contains 1235 specifications and standard methods, including both formal and tentative ones. It also includes the emergency standards and alternate provisions adopted because of wartime conditions. The work appears in three volumes: Part 1, Ferrous and Nonferrous Metals; Part 2, Constructional Nonmetallic Materials; Part 3, General Nonmetallic Materials. Each part has an index and may be purchased separately.

A.S.T.M. STANDARDS ON PAPER AND PAPER PRODUCTS, prepared by A.S.T.M. Committee D-6 on Paper and Paper Products; Methods of Testing Specifications, December, 1944. American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa., 1945. Paper, 6×9 in., 182 pp., illus., diagrams, charts, tables, $1.50. The second edition of this publication provides in their latest form, as of November, 1944, all of the 49 specifications, test methods, and related standards that have been developed through the work of the A.S.T.M. committees on paper and paper products. The wide coverage includes laminated sheets, vulcanized material for electrical insulation, adhesiveness of gummed tape, and flammability, as well as the more directly related subjects.

AEROPLANE PRODUCTION YEAR BOOK AND MANUAL (II) 1944, edited by M. M. Williamson and G. W. Williamson, introduction by Sir R. H. Dobson. Paul Elek (Publishers) Ltd., Africa House, Kingsway, London, England, 1945. Cloth, $5^1/_2 \times 8^1/_2$ in., 573 pp., illus., diagrams, charts, tables, 40s. This continuation of a series covering aircraft production processes deals mainly with heavy bombers and the transition to civil aircraft. Part I contains several articles on various phases of air transport and the aircraft industry. The rest of the book describes equipmment and processes under the following headings: materials of aircraft production; specialized airframe processes; airframe tools; testing equipment; production of complete aircraft; installation and equipment; and ground equipment. British practice only is considered, and the descriptions are of products of specific British manufacturers. The volume is well indexed.

AEROSPHERE, 1943, including Modern Aircraft, Modern Aircraft Engines, Aircraft Statistics, Buyer's Guide, edited by G. D. Angle and others. Aerosphere, Inc., New York, N. Y., 1944. Cloth, $8^1/_2 \times 12$ in., paged in sections, illus., diagrams, tables, $15. "Aerosphere" provides brief descriptions of the aircraft and aircraft engines currently being built throughout the world, together with statistical information on these industries and a buyer's guide. The arrangement is by countries, then by manufacturers. The specifications, construction, equipment, instruments, performance, and engine for each model are stated, usually with a photograph of the plane or drawing of the engine.

DAMPING CAPACITY: a General Survey of Existing Information. (Association Series No. 657.) By F. C. Thompson. British Non-Ferrous Metals Research Association, London, N.W.1, England, 1944. Paper, $6 \times 9^3/_4$ in., 37 pp., diagrams, charts, tables, 3s 6d. This survey of the damping capacity of metals and alloys deals with such matters as the significance of damping capacity from the metallurgical and the engineering points of view, the directions in which quantitative information is lackng and needed, the nature of experimental investigations likely to give results of practical value, and the validity of present methods of determining damping capacity. A bibliography is included.

ENGLISH-SPANISH COMPREHENSIVE TECHNICAL DICTIONARY of Aircraft, Automobile, Electricity, Radio, Television, Petroleum, Steel Products. By L. L. Sell. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1944. Cloth, $8^1/_2 \times 11^1/_2$ in., 1477 pp., $30. This dictionary is a monumental work which translators will find indispensable. More than five-hundred thousand current technological terms are included. The mechanical and electrical fields are especially well covered. Differences in English and American usage are noted, as well as the differences in terminology between South American countries.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

International Conference on Screw Threads to Be Held at Ottawa

HIGH hopes are held by leading screw-thread experts of the United States, Canada, and Great Britain that the Conference on Unification of Engineering Standards, Ottawa, Canada, planned for late this summer, will bring unification of American-British-Canadian thread standards nearer to a reality.

The Ottawa conference is being held under the auspices of the Combined Production and Resources Board, of which William L. Batt is the U. S. Deputy Member. Members of the steering committee are Elmer J. Bryant, Greenfield Tap & Die Corp., and Ronald Allwork, CPRB, representing the United States; Stanley J. Harley, Coventry Gauge & Tool Co., Ltd., and Lord Pentland, representing the United Kingdom; and James G. Morrow, Steel Co. of Canada, Ltd., and James H. Boyd, representing Canada.

Existing screw-thread differences stem from heterogeneous designs developed during the early nineteenth century when the great era of mechanical achievement was getting under way in England and America. In 1841, Sir Joseph Whitworth set up the British standard which now bears his name. But in 1864, William Sellers developed a screw thread that was easier to produce in the United States than the Whitworth.

One of the basic problems to be resolved by the Ottawa conference is the British 55-deg vs. the American 60-deg thread forms. Back in April, 1861, The Franklin Institute of Philadelphia began an investigation which developed a series of threads with the 60-deg form, and this was then variously known as the Franklin Institute, Sellers, and United States thread series. It is now known as the American (National) Coarse Series. In 1905, a series of finer pitches with the 60-deg angle were developed by the Association of Licensed Automobile Manufacturers, the basis of the present S.A.E. series. This was revised, as required by the industry, and specified external and internal screw threads from $^1/_4$ to $^3/_4$ in. diameter.

The A.L.A.M. standard was adopted and extended to $1^1/_2$ in. diameter in June, 1911, by the Society of Automobile Engineers as the S.A.E. Screw Standard. In January, 1915 (S.A.E. Transactions, 1915, p. 16), this series was again extended and referred to as the S.A.E. Coarse series, and an S.A.E. Fine series for $1^5/_8$ in. diameter and larger adopted with 16 threads per in. In March, 1918, the S.A.E. Fine was extended downward from $1^1/_2$ to $^1/_4$ in. diameters, inclusive, and adopted at that time, primarily for aeronautic use.

The present American Coarse (NC) series was the former United States Standard; the American Fine (NF) series was the previous S.A.E. Coarse series extended to include the numbered sizes; and the present American Extra Fine (EF) series was the former S.A.E. Fine series.

The 8, 12, and 16 threads per inch series were adopted later as the American Standard in order to avoid inconsistencies in practice and to provide adequate screw-thread specifications for all uses. In certain sizes these threads duplicate the present regular series but in such cases the specifications are identical.

The American Standard 16 Thread Series, Class 2 for screws and nuts, and sizes $4^1/_4$ to 6 in., inclusive, in the Class 3 tables for screws and nuts, were added to the S.A.E. Standard in January, 1942.

In the Extra Fine series the pitch for the $1^5/_8$ in. diameter and larger sizes is 16 threads per inch, the detail dimensions being given in the tables of the 16 pitch threads for the corresponding classes of fit.

A machine-screw series of diameters under $^1/_4$ in. was early recommended by The American Society of Mechanical Engineers, and later adopted in the American Coarse (NC) standard series.

Further unification of the various American threads series was undertaken in 1918 when the National Screw Thread Commission was established by Act of Congress to establish standard threads for the various governmental services with the S.A.E. and A.S.M.E. the industry representatives—written into the law.

As industrial expansion took place in new fields, such as aeronautics, for example, the value of special threads—Acme, improved buttress forms, and instrument series—became apparent for special applications. Demands of war forced widespread adoption of these, review of which will be an important function of the Ottawa Conference.

The war also brought about the truncated Whitworth form as a production compromise particularly urgent in artillery parts and other products for lend-lease production for England. This form is interchangeable with the standard Whitworth and enabled the manufacture of vast quantities of war material for both American and Allied use by U. S. war plants.

The Ottawa Conference is the third of a series of important co-ordinated events toward the unification of British, Canadian, and American screw-thread standards. The first was the August-September, 1944, Joint U. S.-Canada Screw Thread Mission conferences in England. The second was a conference in New York last November reporting the progress and the assignment of specific tasks to a number of subcommittees.

Actions of A.S.M.E. Executive Committee At Meeting Held at Headquarters, May 24, 1945

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held at Society headquarters, New York, N. Y., on May 24, 1945. There were present: Alex D. Bailey, chairman; R. F. Gagg, vice-chairman; A. C. Chick, D. W. R. Morgan, and A. R. Stevenson, Jr., of the Committee; J. J. Swan (Finance), R. M. Gates, junior past-president, G. L. Knight (Pension), and C. E. Davies, secretary.

The following actions were of general interest.

Pensions

The resolution and rules and regulations for the retirement system, submitted by the Pension Committee, were discussed and approved.

Committee Discharged

The Special Research Committee on Detonation Propulsion Engine, organized at the request of the Office of Production Research and Development, was discharged with thanks on recommendation of the Research Committee.

Standard Approved

On recommendation of the Standardization Committee, approval was voted of the adoption, as a standard of the Society and for transmission to the American Standards Association for approval as an American Standard, of the proposed American Standard for Screw Threads for High-Strength Bolting.

International Relations

It was voted to recommend to the Council that it adopt a statement of purposes and objectives for the Committee on International Relations of which R. M. Gates is chairman. The statement follows:

(1) To co-operate with engineers in other countries, foreign institutes of engineering, and government agencies in the practical advancement of engineers and the use of engineering techniques.

(2) To assist in furthering engineering education and knowledge in those countries where it has been hampered or unavailable and to render this assistance in the form it will be most usable and helpful.

(3) To give such aid as may come within the scope of our professional societies to those countries in need of engineering services for the readjustment of economic life.

(4) To render assistance, with the approval of our State Department, to any accredited agency, group, or individual of another country in need of our engineering service.

(5) To keep the members of the Engineers' Joint Council advised, through their secretaries, of our activities and plans.

(6) To establish a clearing house for information at the Engineering Societies Building, New York, staffed with competent personnel, to render such services as are necessary.

John Fritz Medal Board

Alex D. Bailey was designated representative on the John Fritz Medal Board of Award for a four-year term starting Oct. 1, 1945.

C.E.D. Construction Committee

Robert S. Hackett was appointed A.S.M.E. representative on the Construction Action and Advisory Committee of the Committee for Economic Development.

Research Board for National Security

Approval was voted on Senate Bill S 825 establishing a Research Board for National Security, subject to legal review of the bill.

H. G. Thielscher Resigns

The resignation as a manager, A.S.M.E., of H. G. Thielscher because of additional duties which made it impossible for him properly to fulfill the duties of manager was accepted with regret.

Janet E. Bachman

The Executive Committee expressed its sincere regret of the death on April 29, 1945, of Janet E. Bachman, who assisted the Committee on Meetings and Program. Miss Bachman had completed 25 years of service with the Society on April 10, 1945.

Gift of R. C. Guest

The offer of Richard C. Guest, of Worcester, Mass., to give to the Society a full set of A.S.M.E. Transactions to aid in the restoration of a devastated engineering library in one of the allied countries was accepted with appreciation.

Appointments

Approval was voted of the following appointments:

Power Test Code Committees, No. 3 on Fuels, Martin A. Mayers; No. 20 on Speed, Temperature, and Pressure Responsive Governors, C. E. Kenney.

Joint A.I.E.E.-A.S.M.E. Committee on Specifications for Prime Mover Speed Governing, C. E. Kenney.

1945–1946 Budget

Following adjournment, the Executive Committee met with the Finance Committee and representatives of the spending committees, to discuss the 1945–1946 budget and other financial matters. In addition to the persons attending the previous meeting there were present: W. H. Sawyer, J. N. Landis, and F. E. Lyford of the Finance Committee; K. W. Jappe, treasurer, and J. L. Kopf, assistant treasurer, R. A. North (Meetings and Program), Edgar J. Kates (Publications); and D. C. A. Bosworth, controller.

Dues of Members Abroad

On recommendation of the Finance Committee the Executive Committee of the Council voted to approve acceptance of dues in Canadian currency from members residing in Canada if payments are made on or before December 1, and to approve extension for another year of the suspension of dues for members residing abroad if such members cannot secure the proper export permit for the payment of dues.

A.S.M.E. Boiler Code Committee Holds Dinner for Inspectors

At the Engineers' Club, New York, N. Y., on Thursday evening, May 24, the Boiler Code Committee of The American Society of Mechanical Engineers, entertained at dinner its honorary members, representatives and officers of the Society, members of its subcommittees, special committees, and Conference Committee, many of whom were attending a convention of the National Board of Boiler and Pressure Vessel Inspectors.

T. B. Allardice, member A.S.M.E., mechanical engineer, American Gas and Electric Service Corporation, New York, N. Y., and member of the Boiler Code Main Committee, acted as toastmaster and insisted upon the self-introduction of each of the 100 persons present.

H. B. Oatley, member A.S.M.E., vice-president, Superheater Company, New York, N. Y., chairman of the Boiler Code Main Committee, said that one purpose of the dinner was to afford an opportunity for members of the Boiler Code Committee to get better acquainted with its Conference Committee whose members represent the Boiler Code enforcement authorities.

Thanks and appreciation of all who had assisted in the work of the Boiler Code Committee were expressed by Dr. D. S. Jacobus, past-president and honorary member A.S.M.E., and former chairman of the Committee.

The chairman of the National Board of Boiler and Pressure Vessel Inspectors, Gerald Gearon, chief deputy inspector, Boiler Inspection Department, City of Chicago, member A.S.M.E., expressed the appreciation of the members of the Board for the opportunity of meeting with the Boiler Code Committee. Both groups, he said, were interested in the same objective, which could best be obtained by co-operation. He praised highly E. R. Fish, fellow A.S.M.E., former engineering consultant, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., former chairman of the Boiler Code Committee, and honorary member of the National Board, and presented him with an illuminated scroll bearing the names of the members of the Board as a testimonial of their esteem.

In his response Mr. Fish reviewed some of the accomplishments of the Board and his 27 years' relationship with it. The work of the Board, he asserted, had been of real value to the Committee. He had always considered it his duty to attend meetings of the Board and had never missed one. The Code, he said, had been a lifesaver to Board members. All points of view were necessary, he contended, and the opinion of the majority should prevail.

Speaking for the president of the A.S.M.E., Alex D. Bailey, who was unable to be present, and as Secretary of the Society, Col. C. E. Davies said that Mr. Bailey would have been glad to welcome the group as a co-ordinated design-enforcement team acting under high-grade leadership. This team, he said, was important to the A.S.M.E. Without good enforcement, laws were useless, and without good laws, enforcement was useless. He was paying tribute where tribute was due.

It was the objective of the Boiler Code Committee, he explained, to bring about

Objectives of the Management Division of the A.S.M.E.

The purpose of the Management Division is to develop a sound philosophy of management, and techniques for applying the engineering approach in behalf of more effective and efficient organization and operation, this to be done through the preparation and discussion of papers and reports, the processes of research, education, and other appropriate means.

I Administration

1 Management philosophy and principles
2 Management policies and policy building

II Organization and Control

1 Management of physical property
  (a) Selection of the location (site), machinery, equipment, furniture, fixtures, services, and buildings
2 Organization of the physical property
  (a) Layout of work areas
  (b) Organization and layout for storeskeeping, safety, and effective control of operations
  (c) Organization for handling materials and work in process
3 Maintenance management
4 Management of manpower
  (a) Selection, testing, employment, placement, morale building, and employee services
  (b) Training executives, supervisors, and workers
  (c) Safety and health
  (d) Collective bargaining
  (e) Wage and salary administration, including compensation systems, job evaluation, and merit rating
5 Control of Operations
  (a) Planning for control and development of control systems
  (b) Inspection and quality control
  (c) Simplification and standardization
  (d) Material control, including purchasing, salvage, and conservation
6 Distribution: Warehousing, transportation, wholesale and retail marketing, and advertising
7 Budgeting, cost control, cost accounting and estimating
8 Methods engineering, including operation analysis, and time and motion studies.

III Research Development

1 Research, development, modernization, measurement of results as they pertain to materials, products, methods, and personnel.

workable results to satisfy the needs of design and of enforcement. He expressed the satisfaction and appreciation of the Society for the accomplishments of all. He hoped that the "team" would carry on effectively. Its motives were sound, he said, its leadership good and unselfish, and its objectives worth while. Both the Board and the Committee were "trying to get the same place." He concluded by expressing the wish for "continuing and continued success."

C. O. Myers of Columbus, Ohio, member A.S.M.E., secretary and treasurer of the Board, and member of the Boiler Code Main Committee, personally introduced members of the Board from Manitoba, Ontario, Quebec, and Saskatchewan, Canada.

What the Boiler Code had meant to the war effort was explained by H. Le Roy Whitney, fellow A.S.M.E., honorary member of the Boiler Code Committee, adviser to the Chairman of the War Production Board, Washington, D. C. He said that the adoption of welding by the Boiler Code Committee had given great impetus to that important production and had inspired confidence in it. Welding, he asserted, had made high production for the war possible. He also praised the work of inspectors, of whom there had been too few during the war. However, they had done their work so satisfactorily that no manufacturer had ever complained of the work of members of the Board. Co-operation, he said, had been "wonderful." Without welding and standardization, he asserted in conclusion, it would have been hard to win the war.

E. G. Bailey and J. C. Hunsaker Made Honorary Members, I.M.E.

By radiogram from London announcement has been received by the Secretary of The American Society of Mechanical Engineers that the Council of The Institution of Mechanical Engineers have elected to honorary membership in the Institution E. G. Bailey, fellow A.S.M.E. and A.S.M.E. Medalist, 1942, president, Bailey Meter Company, and vice-president, The Babcock and Wilcox Company; and Jerome C. Hunsaker, honorary member A.S.M.E., and head, department of mechanical engineering, Massachusetts Institute of Technology.

W.S.E. Elects Officers

Dr. Henry T. Heald, member A.S.M.E., president of the Illinois Institute of Technology, has been elected president of the Western Society of Engineers for the year 1945–1946.

Titus G. Le Clair, chief staff engineer, Commonwealth Edison Co., becomes first vice-president, Robert B. Harper, vice-president, Peoples Gas Light and Coke Co., becomes second vice-president, and M. W. Casad, plant extension engineer, Illinois Bell Telephone Co., was elected treasurer.

New members of the society's board of direction are Homer K. Smith, Westinghouse Electric Corporation, and Ralph E. Turner, member A.S.M.E., editor, *Power Plant Engineering*.

George T. Seabury, Secretary A.S.C.E., Dies

George T. Seabury, secretary of the American Society of Civil Engineers since 1925, died suddenly on May 25, 1945, after a two-day illness.

Mr. Seabury, who had reached the age of 65 on April 12, 1945, had, in January of this year, indicated to the A.S.C.E. Board of Direction his intention of retiring from the secretaryship. In April the Board of Direction persuaded Mr. Seabury to accept appointment as assistant to the president on a part-time basis. This action was to have become effective on June 1 when Col. William N. Carey, named by the Board to succeed Mr. Seabury as Secretary, was slated to be released from his duties as chief engineer of the Federal Works Agency and from active duty with the Army.

Mr. Seabury was born in Newport, R. I., and was graduated from the Massachusetts Institute of Technology in 1902 with the degree of S.B. in Civil Engineering. From 1902 to 1905 he served as field engineer for contractors and construction engineers on subways, Riverside Drive, Grand Central Terminal, and other projects in New York City. The next five years were spent with the Board of Water Supply, New York City, on the Catskill Aqueduct. In 1915 he went to Providence, R. I., on a new water-supply development.

During World War I Mr. Seabury served as a major in the Quartermaster Corps, U. S. Army. Returning to civil life he organized the firm of George T. Seabury, Inc., of which he was president and general manager from 1919 to 1923. The twenty years and five months during which he served as secretary of the A.S.C.E. included some of the most critical times which the society, engineers in general, and the nation have ever faced. To the tasks and problems which these conditions generated he gave unstintingly of his time and energy, his wise counsel, and his warm human sympathies.

Van Leer Elected Chairman of Georgia Ports Authority

Col. Blake R. Van Leer, president of Georgia School of Technology, was elected chairman of a three-man Georgia State Ports Authority on Tuesday, May 22, 1945.

The Ports Authority was created by recent state legislation (Act No. 422) as an instrument of the State of Georgia and a public corporation. It is authorized to "promote, develop, construct, equip, maintain, and operate at any seaports of the state, terminal facilities of all kinds," and is authorized to issue negotiable revenue bonds, not to exceed $15,000,000 to pay the cost of such projects.

The election of Colonel Van Leer as chairman was the first official act of the Authority. The body had just been sworn in by Governor Ellis Arnall in the executive offices at the state capitol, before delegations from the ports of Savannah and Brunswick. The ceremony was timed to coincide with a series of maritime exercises held that day, included among which were felicitations between the governors of Georgia and Connecticut by radio on the 126th anniversary of the sailing of the *S. S. Savannah* in the first transatlantic voyage of a steam-propelled vessel.

Two of the members of the Authority are appointed from designated congressional districts, so as to have specific representation for the ports of Savannah and Brunswick. Plans are already under way for the expansion and full utilization of these ports. Colonel Van Leer is member from the state at large.

A. A. Potter Named Acting President of Purdue

A. A. Potter, past-president A.S.M.E. and Dean of Engineering, Purdue University, has been appointed acting president of Purdue University as of July 1, 1945. He will continue as dean of engineering.

Society of Industrial Designers Formed

Announcement has been made of the formation of the Society of Industrial Designers. The announcement says that "every industrial designer in good standing in the United States will be eligible to membership . . . To distinguish the profession from other design fields the principal requirement for membership will be that each candidate for membership must have successfully designed a diversity of products for machine and mass production or must be professionally engaged in teaching in this field.

"The society will assume the tasks and responsibilities of a professional association. A code of professional practice is in preparation. Information, advice, and assistance will be available to people and institutions engaged in teaching industrial design or engaged in public education in this field."

Officers of the society are: Walter Dorwin Teague, president; Raymond Loewry, chairman of the executive committee; Henry Dreyfuss, treasurer; and Egmont Arens, secretary. Philip McConnell has been appointed executive secretary of the society whose temporary offices are at 55 West 42nd St., New York 18, N. Y.

Welding Research Council Appoints W. Spraragen as Director

The Welding Research Council of the Engineering Founda ion has announced the appointment of W. Spraragen, present Executive Secretary of the Council, to the newly created position of Director. The Welding Research Council is a co-operative scientific research organization which is engaged actively in the study of matters related to the science and art of welding. Sponsored by the American Welding Society and the American Institute of Electrical Engineers it operates in close co-operation with all major engineering societies. It has an annual budget of more than a quarter of a million dollars and these funds for research are provided by large users of welding and welded products, and various governmental agencies.

An important duty assigned to Mr. Spraragen in his new post will be the administration of the work of a Pressure Vessel Research Committee now being organized which contemplates the expenditure in this field of $225,000 over a three-year period.

William N. Carey Named Secretary A.S.C.E.

THE Board of Direction of the American Society of Civil Engineers has named William N. Carey to succeed George T. Seabury as secretary of the Society.

Colonel Carey, a consulting engineer of St. Paul, Minn., has been serving as chief engineer of the Federal Works Agency, from which position he was released for his new duties on June 1, 1945. He is a graduate of the University of Minnesota and has served a three-year term on the Board of Direction of the A.S.C.E. During World War I he was captain and then major in the Corps of Engineers. He returned to active service in 1941.

Prof. Andrew Robertson Is New I.M.E. President

THE new president of The Institution of Mechanical Engineers, Prof. Andrew Robertson, is described in the *Journal* of the Institution, April, 1945, as follows:

Professor Andrew Robertson, D.Sc., Wh.-Ex., M.I.Mech.E., F.R.S., has been professor of mechanical engineering in the University of Bristol since 1919 and has contributed many accounts of his researches to published mechanical-engineering knowledge. His researches have dealt mainly with materials and structures and have included the testing of timber, glue, rubber, and other materials of construction for aircraft and aero engines. Professor Robertson has made a special study of the transition from yield to the plastic state in ductile materials, commencing with a joint paper with Prof. Gilbert Cook to the Royal Society in 1913, and including a special study of the drop of stress at yield in Armco iron in conjunction with A. J. Newport. He has also published several papers on the strength of tubular and other struts, for one of which he was awarded in 1925 the Telford Gold Medal of the Institution of Civil Engineers.

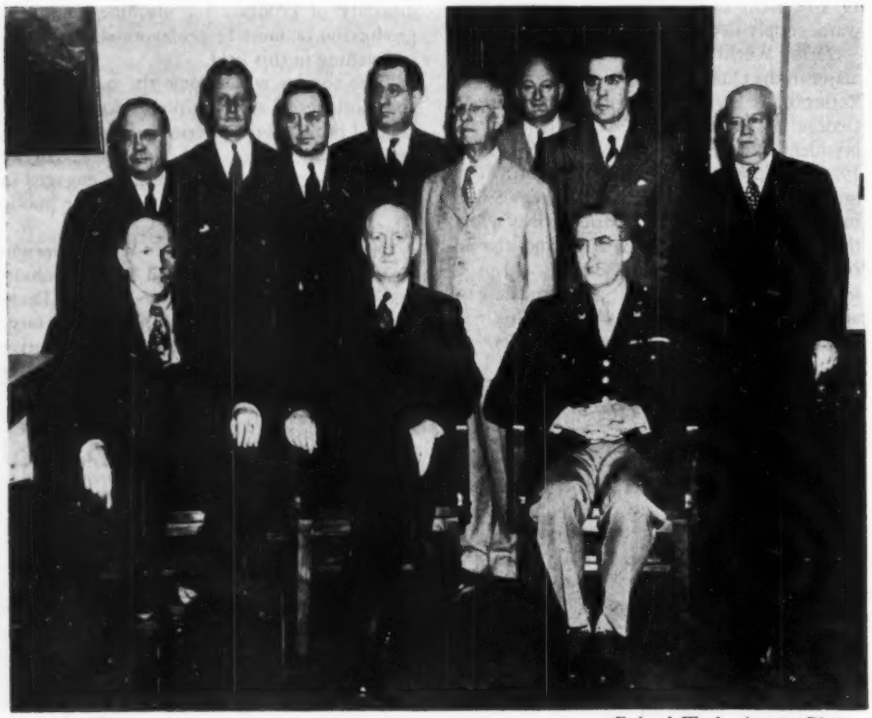
Appointed to Many Committees

His special knowledge of these subjects has led to his appointment to a number of committees of the British Association and the Department of Scientific and Industrial Research, and in 1935 Prof. Andrew Robertson was appointed a member of the Advisory Council of the Department of Scientific and Industrial Research. In 1941 the Lord President of the Council with the approval of the Prime Minister, appointed an Engineering Advisory Committee under the chairmanship of Lord Hankey, to advise the Government upon engineering questions connected with the war. The committee consisted in all of ten members, seven of whom were selected after consultation with the three major engineering institutions. Two of those selected were the retiring president, Dr. Harry R. Ricardo, and the new president.

Professor Robertson served his apprenticeship with Messrs. James Robertson and Sons of Fleetwood. He obtained a Lancashire County Council Ashbury Scholarship, a Whitworth Exhibition, and a Fairbairn Prize, and in 1905 he graduated in the University of Manchester with first-class honors. After further practical experience with Messrs. James Robertson and Sons, mainly on marine repair work, he returned to Manchester University in 1908 as Demonstrator in Engineering, and in 1912 he became a Vulcan Fellow of the University. In 1915 he joined the engine section of the Air Department of the Admiralty as Lieutenant R.N.V.R., and in 1918 he became officer in charge of mechanical testing at the Royal Aircraft Establishment, and was promoted to Lieutenant Commander. On the fusion of the R.N.A.S. and Air Force, he became Major (Technical), R.A.F.

Elected Fellow of Royal Society in 1940

Professor Robertson was appointed to the chair of mechanical engineering at Bristol in October, 1919, and in 1924 he was also appointed principal of the Merchant Venturers' Technical College in which the faculty of engineering of the university is conducted. In 1940 he was elected a Fellow of the Royal Society. He has given long and devoted service to the Institution. Elected an Associate Member in 1911, and a Member in 1920, he undertook the office of Honorary Secretary of the Western Branch on its formation in 1924 until 1929. In 1931 he was elected Chairman of the Branch and was a Member of Council for that year. In 1938 he was elected Member of Council and in 1941 Vice-President.



Federal Works Agency Photo

MEMBERS OF THE PUBLIC WORKS CONSTRUCTION ADVISORY COMMITTEE ANNOUNCED BY MAJOR GENERAL PHILIP B. FLEMING, FEDERAL WORKS ADMINISTRATOR

(Representatives of twelve national organizations engaged in or responsible for the planning, design, construction or operation of public works will advise with General Fleming on postwar public works needs.

Members of the committee, from left to right, are: *Seated:* F. Stuart Fitzpatrick, U. S. Chamber of Commerce, committee secretary; E. Lawrence Chandler, American Society of Civil Engineers, committee chairman, and Colonel William N. Carey, chief engineer of the federal works agency, who will act as contact between the committee and General Fleming. *Standing:* Earl Mallery, American Municipal Association; Major Edmund R. Purves, American Institute of Architects; S. Logan Kerr, The American Society of Mechanical Engineers; H. E. Foreman, Associated General Contractors of America; Frederic Bass, American Public Works Association; J. W. Follin, Producers' Council, Inc.; B. E. Crihfield, alternate for Frank Bain, Council of State Governments; and R. J. Gray, Building and Construction Trades Department, American Federation of Labor.

Two other committee members not shown in the photograph are: Paul Betters, U. S. Conference of Mayors, and Hal H. Hale, American Association of Highway Officials.)

National Instrument Society Formed

A NEW national society to be known as The Instrument Society of America was organized in Pittsburgh on April 28 at a conference attended by delegates from 15 measurement and control instrument societies that have been growing in different industrial centers throughout the country.

The purpose of the society will be to advance the arts and sciences that are connected with the theory, design, manufacture, and use of instruments. The society is nonprofessional and offers membership to any person, firm, or institution interested in the objectives of the society.

Officers pro tem. were elected as follows: president, A. F. Sperry (Chicago); vice-president, C. F. Kayan (New York); treasurer, C. E. Fry (Pittsburgh); secretary, Richard Rimbach (Pittsburgh). Various committees were also appointed to proceed with the organization work and preparation of constitution and by-laws. The office of the secretary is the temporary office of the society and is located at 1117 Wolfendale St., Pittsburgh 12, Pa.

President's Page

To A.S.M.E. Members in the Armed Forces

TO those of you who are planning to return to your old jobs this letter may have little value, others, however, may find it of interest. In any event, your member friends at home want you to know that they are thinking of you, that they want to be of assistance in any way they can, either now or when you return to civilian life, and that they will continue to support your efforts in every way.

Your replies to Past-President R. M. Gates's letter have been studied carefully but it is impossible to answer all of the questions in a single letter. It seems timely, however, to tell you a few of the things that are under way and in which you may be interested.

In the reconstruction and postwar period it is evident that there will be a great demand for engineers. There will be a shortage of engineers due to the fact that the Armed Services have taken so many young men who would have otherwise acquired an engineering education. There is every indication of increased production for civilian use with changes and improvements in products so that engineers will be in demand. During the last few years when production has been pushed to the limit, industry has realized how important the engineer is to its success.

There will be refresher courses and training courses set up by industry as well as by educational institutions to bring you up to date. For those of you who have not finished your schoolwork there will be every facility, either in industry or in day or evening classes provided by educational institutions, for completing your education.

Your Society is anxious to welcome you back to active membership and to advise you regarding your rights and privileges under Federal and State programs. We will help in establishing retraining aids and to bring you up to date on technical matters in which you may be particularly interested. We will be glad to help on your employment problems. With the thought that your local sections may be most effective in helping you, they are being organized to give advice and assistance in getting you located in your home community.

(*Signed*) Alex D. Bailey, *President*, A.S.M.E.

(*Text of a letter being sent with a questionnaire to A.S.M.E. members in the Armed Forces.*)

Local Sections

AT THE GROUP IV CONFERENCE

(*Back row, left to right:* Prof. J. B. Jones, head, mechanical-engineering department, V.P.I., member, National Nominating Committee; Arthur Roberts, Jr., chief engineer, Lynchburg Foundry Co., Lynchburg, Va.; Prof. Fred H. Thomas, University of Tennessee, Knoxville, Tenn. *Middle row, left to right:* Ernest Hartford, executive assistant secretary, A.S.M.E.,; Prof. T. C. Brown, North Carolina State College, Raleigh, N. C.; Eugene W. O'Brien, vice-president, W. R. C. Smith Publishing Company, Atlanta, Ga.; V. A. Rogers, consulting engineer, nitrogen division, Solvay Process Company, Hopewell, Va.; E. M. Williams (back of Mr. Rogers) chief engineer, Clinchfield Fuel Company, Spartanburg, S. C.; Bruce Sams, chief engineer, Southern Cotton Oil Company, Savannah, Ga.; Harry M. Mouat, manufacturer's representative, Birmingham, Ala.; John A. Dodd, manufacturer's representative, Atlanta, Ga.; Prof. Ernest S. Theiss, Duke University, Durham, N. C. *Front row, left to right:* Stephen C. Moxley, chief engineer, American Cast Iron Pipe Company, Birmingham, Ala., member of National Local Sections Committee; Col. Blake R. Van Leer, president, Georgia Tech, member National Committee on Medals; John Parker, manufacturer's representative, Atlanta, Ga., chairman Atlanta Local Section; Edward E. Williams, superintendent of plants, Duke Power Company, chairman of Meeting and Regional vice-president nominee; Neal H. Brown, manufacturer's representative, Charlotte, N. C.; secretary of conference, Dean Ford L. Wilkinson, Speed Scientific School, University of Louisville, Louisville, Ky., national vice-president.)

Atlanta Section Host to Group IV Conference

On May 21 and 22 the Section acted as host to the conference of Group IV comprising the sections located in the southeastern states. The conference was held at the Piedmont Hotel, Atlanta, Ga., and 15 delegates and special representatives were in attendance from sections other than Atlanta. John Dodd represented the Atlanta section. The purpose of the conference was to discuss and pass on matters of agenda that vitally affect the operation of the Society and to nominate a national vice-president. Ed. E. Williams of Duke Power Co., Charlotte, N. C., was unanimously nominated for that office. Prof. E. S. Theiss of Duke University was elected junior delegate of the conference; Prof. F. H. Thomas, University of Tennessee, first alternate delegate, and Harry Mouat of Birmingham, Ala., second alternate delegate; Paul R. Yopp, Atlanta, Ga., was elected to represent Group IV on the National Nominating Committee; alternates elected were Neil Brown, Charlotte, N. C., Prof. J. B. Jones, V.P.I., and Harry Mouat, Birmingham, Ala.

Central Indiana Section Meets With Purdue University Branch

A combined meeting of the Section with the Purdue student branch was held at Purdue University, Lafayette, Ind., on May 11. The meeting opened with an informal inspection of several of the laboratories at the University, followed by dinner in the west faculty lounge of the Union Building. Three instructors in the school of mechanical and aeronautical engineering were the speakers; each has been doing research work for the Army during the war. Dr. C. E. Warner spoke first on "Engineering Applications of Infrared Photography." He was followed by A. S. Hall, whose subject was "How Fluids Flow in a Diverging Channel," and next, N. Kulik gave a talk on "Evolution of Jet and Rocket Propulsion Devices."

On April 13 the last formal meeting of the year was held at the Antler's Hotel, Indianapolis, Ind., when C. A. Page, gage engineer for the Pratt-Whitney Company, gave a very excellent paper on "Gaging and Gaging Practices." Over fifty attended the dinner, and the audience who attended the lecture was even larger.

Chicago Section Hears Program Sponsored by Management Division

Harold F. North, director, industrial relations, Swift and Company, Chicago, Ill., was the speaker at the dinner meeting on May 14 at the Chicago Engineers' Club. In his talk Mr. North developed the theme that good industrial relations are a matter of good engineering as well as good human relations. He dealt with the application of these basic approaches to the tangled problem of readjusting a war economy and the war veteran to the postwar industrial situation—a subject of paramount importance to managers and engineers. This program was sponsored by the management division of the Section.

Jet Propulsion and Rockets Subject at Cleveland Section

On May 10 at the Hotel Statler, Cleveland, Ohio, Dr. Lionel S. Marks, fellow A.S.M.E., professor emeritus, mechanical engineering, Harvard University, Cambridge, Mass., spoke to an audience of over 900 on "Recent Developments in Jet Propulsion and Rockets." This lecture, which was illustrated, described the mechanics of the gas turbine and jet propulsion, the advantages of each, and the postwar possibilities.

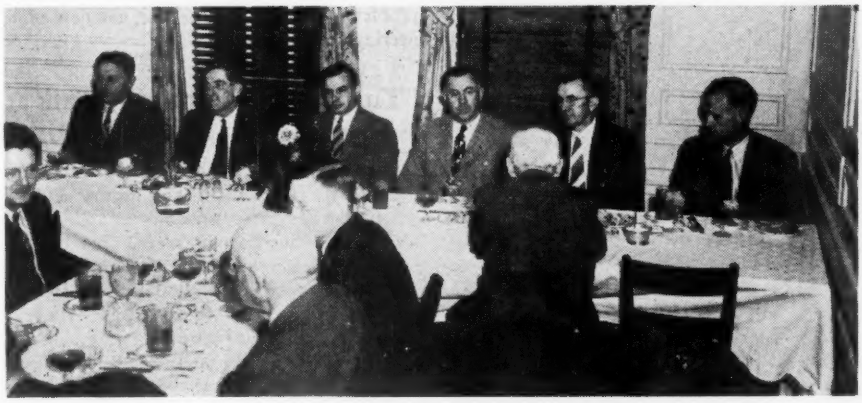
East Tennessee Section Has Two Speakers

At the May 25 meeting at the Kingsport Inn, Kingsport, Tenn., Lieut. Col. John W. Quillian spoke on "Ordnance," and James Ellis, member A.S.M.E., superintendent engineering and services division, Tennessee Eastman Corporation, Kingsport, Tenn., gave a talk on "Education for Industrial Work." Seventy-seven members and guests heard these speakers.

The May 29 meeting, held at the S & W Cafeteria, Knoxville, Tenn., was a Group IV 1945 regional conference meeting, at which Prof. F. H. Thomas, associate professor of mechanical engineering, University of Tennessee, was the speaker. War movies were shown.

Hartford Section Elects New Officers

On May 8 at the Hartford Club, Hartford, Conn., officers were elected for the coming season as follows: T. S. Cassidy, Jr., chairman, E. R. Lewis, Jr., vice-chairman, and R. L. Weil, secretary-treasurer. L. P. LaBel was elected chairman of the program committee. Problems of reconversion and rehabilitation were discussed. It was decided to devote the section's fall meeting to a discussion of these two subjects, with several prominent engineers and industrialists as speakers.



GROUP AT LUNCHEON, GROUP IV CONFERENCE

Inland Empire Section Awards Prize to U. of I. Student

On May 11 a meeting was held at the Desert hotel, Spokane, Wash., when two University of Idaho students gave papers. The first, "Powdered Metallurgy," was presented by Wm. B. Abbott, and the second, "Nitriding Process," was given by Ira Jacobsen, who won first prize entitling him to a junior membership in A.S.M.E.

Memphis Section Hears Roscoe W. Morton, Manager A.S M.E.

On May 7 a meeting was held at the Hotel Peabody, Memphis, Tenn., when Prof. Roscoe W. Morton, manager A.S.M.E., of the University of Tennessee, gave a talk on "Streamlined Trains." He described the various types of streamlined train construction and the various types of power plants and details of operation. The talk was illustrated.

Metropolitan Section Has Special Meeting

A special meeting was held on May 28 at the Engineering Societies Building, New York, N. Y., sponsored by the Fuels Division, when a paper, originally planned for the canceled Boston Spring Meeting, was read, entitled "Experimental Study of the Flow of Coal in Chutes at Riverside Station." The authors, Harry E. von Hohenleiten and Edgar F. Wolfe of the Consolidated Gas Electric Light & Power Company, Baltimore, Md., were the speakers. Slides illustrated the talks by these two authors. An interesting open discussion followed.

Mid-Continent Section Holds Open Meeting

An open meeting was held in the junior ballroom, Mayo hotel, Tulsa, Okla., on April 26, when an interesting talk was given by H. K. Ihrig, manager, technical service department, Kobe, Inc. Mr. Ihrig explained the workings of the Kobe hydraulic pump and the methods of paraffin control. Slides were used to depict the important details of the Kobe subsurface pump, and a transparent working model, 10 ft high, was operated so that all valves and moving parts could be seen in motion. Sixty five heard the program.

Philadelphia Section Holds Annual Meeting and Outing

Despite wartime shortages, long working hours, and transportation handicaps, 270 members, their wives and guests gathered on May 22 at the Cedarbrook Country Club for the Section's annual meeting and outing. All agreed that the event provided inspiration, good fellowship, and much needed relaxation.

This Section is fortunate in having an active Woman's Auxiliary, who co-operated in the arrangements for the event and in taking charge of the bridge party. Following an afternoon devoted to the usual outing activities, the dinner-meeting was held, at which those in attendance were fortunate in hearing from Alex D. Bailey, national president of the Society, and from Col. C. E. Davies, its national secretary. We were also honored in having with us David Morgan, vice-president, D. Robert Yarnall, and Nevin Funk. During the business portion of the session, Frank W. Miller of the Yarnall-Waring Company, retiring chairman of the Section, turned over the gavel for the coming year to Justin J. McCarthy of the Cochrane Corporation. Other new officers who were installed included Sidney T. Mackenzie of The Babcock & Wilcox Company, vice-chairman; Albert G. Kisner of the General Electric Company, secretary-treasurer; Benjamin Webb of Combustion Engineering Company; and M. C. Randall of the Philadelphia Electric Company, members of the Executive Committee. Mrs. Frank W. Miller was seated as chairman of the Woman's Auxiliary for a second term.

Dancing and entertainment brought the outing to a successful conclusion.

Raleigh Section Plans for Next Season

At the May 25 meeting held at the Carolina Inn, Chapel Hill, N. C., E. S. Theiss presented an excellent summary of the Atlanta Conference (Group IV), giving a discussion of each agenda item, and explaining how the conference voted on it. Election of officers took place, and activities for the coming season were discussed.

Rock River Valley Section Hears Dr. Carey Croneis

On May 18 at the Cabot Grill dining room, Beloit, Wis., annual ladies' night was held, when 48 members, their wives and guests heard Dr. Carey Croneis, president of Beloit College, speak on "Background for War." This lecture, which was illustrated, traced the origin, location, and development of some of the basic resources particularly valuable in time of war. Dr. Croneis emphasized the importance of oil—its geologic formation, means of location and extraction, and its geographic distribution. He concluded with a discussion of the present and probable future political implication revolving about the ownership of the world's oil supply.

San Francisco Section Visits Joshua Hendy Iron Works

One of the largest meetings of the Section on record was held on April 26, when 272 members and guests visited the turbine and gear

MEMBERS OF SAN FRANCISCO SECTION STUDYING DETAILS OF LOW-PRESSURE CYLINDER FOR 9000-HP STEAM TURBINE

(*Left to right:* J. H. Sontheimer, Lieut. F. S. Cobe, M. M. Tilley, Ken Meguire, Lieut. N. C. Taylor, Lieut. E. N. Rickert, Bern Crowell, and F. L. Maker.)

AT DINNER MEETING AND PLANT VISIT APRIL 26, 1945, TO JOSHUA HENDY IRON WORKS SUNNYVALE, CALIF.

(*Left to right:* C. G. Patch, C. F. Jensky, A. A. Browne, Alf Hansen, chairman, San Francisco Section; G. F. Gayer, Lieut. W. S. Everett, program chairman, San Francisco Section; F. W. Beichley, secretary-treasurer, San Francisco Section; W. P. Dubbs, R. L. Iglehart, chairman, Junior Division of San Francisco Section.)

manufacturing plant of the Joshua Hendy Iron Works, Sunnyvale, Calif. A plant tour occupied the afternoon, with a dinner meeting in the Hendy cafeteria following. The visitors represented practically every manufacturing industry in northern California. The fact that Hendy is the only maker of large turbines with gears in the entire western half of the United States was believed responsible for the large attendance. Three talks made at the meeting by Hendy engineers were illustrated by slides showing manufacturing techniques and operational charts and graphs. H. D. Ewing, head of the turbine engine department, John T. Maddock, gear engineer, and F. W. Peterson, development engineer, in turn told the visitors of the use of the package-type power plant, gear cutting, and turbine design respectively.

Section chairman Alf Hansen presided, George F. Gayer, Hendy chief engineer, acted as master of ceremonies, Lieut. W. S. Everett of the San Francisco Naval Inspection Office was program chairman, and Daniel K. Coyle of Los Altos, Calif., a Hendy engineer, was chairman of arrangements.

At the regular meeting on May 24, which is designated as annual past-chairmen's night, the speaker was Roy A. Hundley, chief engineer, Enterprise Engine & Foundry Company, San Francisco, Calif. Mr. Hundley's talk was entitled "Turbocharging the Four-Cycle Diesel Engine," and his association since 1933 with his company which was one of the original users of exhaust turbocharging gave his discussion the background of long experience.

Southern California Section Hears Three Speakers

A lecture on "Centrifugal Pump With Reference to Viscosity and Suction Characteristics," was given by A. Hollander, member A.S.M.E., consulting engineer, Byron Jackson Company, at the May 4 meeting, held at the University of Southern California, Los Angeles, Cal. This lecture was presented as part of class work for a course in pumps and hydraulics, E.S.M.W.T., conducted by Paul L. Armstrong, past-chairman, Southern California Section.

On May 10 at the Clark Hotel, Los Angeles, W. H. Steinkamp, Brown instrument division, Minneapolis-Honeywell Company, spoke on "Modern Trends in Industrial Instrumentation and Control." Mr. Steinkamp analyzed the factors governing application of process control instruments and recorders, and described the various control circuits and mechanisms, illustrating his talk with slides. It was clear and concise and was interesting to the 60 members and guests.

Another lecture in the Pumps and Hydraulics machinery course, E.S.M.W.T., was presented on May 11 at the University of Southern California, by V. A. Peterson, member A.S.M.E., district engineer, Elliott Company, whose subject was "Mechanical Drives—Steam Turbines."

Serve on War Loan Drive

Serving on the Treasury War Bond Committee for Engineers to solicit purchases of War Bonds during the Seventh War Loan Drive were the following members of the Southern California Section: W. K. Botticher, Joe S. Earhart, M. L. Crater, Geo. L. Harman, C. M. Sandland, P. L. Armstrong, N. Van de Verg, V. A. Peterson and C. W. Huffman.

Tri-Cities Section Hears Talk on Management Problems

Dr. Lillian M. Gilbreth, member A.S.M.E., professor of management at Purdue University, and president of Gilbreth, Inc., Montclair, N. J., spoke on "The Engineer's Part in Solving Today's Management Problems," at the meeting on June 8, in the Hotel Blackhawk, Davenport, Iowa. As professor of management at Purdue University, Dr. Gilbreth has watched the doors of the engineering profession slowly open to women and believes the war has helped to break down the fallacy of their unfitness for engineering jobs. They excell in patience and dexterity, she declares, and if they are backward in the inventive field, it is only because this is new to them. Over 100 members and guests heard this distinguished woman lecturer discuss a timely subject and problems arising out of the war, and new engineering developments.

"Turbine Locomotives" Talk at Washington, D. C., Section

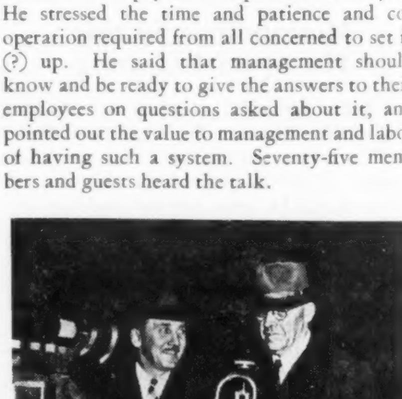
A meeting was held on May 10 in the P.E.P. Co. auditorium, Washington, D. C., when John S. Newton spoke to an audience of 150 on "Turbine Locomotives." The history of the research and development of the turbine locomotive from the early 1900's to the present time was given, and then Mr. Newton explained the design features and performance of the locomotive developed for the Pennsylvania Railroad, known as the S-2.

Western Washington Section Hears About Laminated Timbers

D. O. H. Schrader of Timber Structures, Inc., Seattle, Wash., was the speaker at the May 17 meeting at the Engineers club, Seattle, Wash. He gave a very interesting talk on "Engineering Laminated Timbers for Outdoor Use," explaining the development of waterproof glues for outside use and the number of jobs and applications that have been completed recently. A film, "Engineering in Wood," showing the activities of the Timber Structures, Inc., was shown and enjoyed.

Dean Asa Knowles Speaks at Worcester Section

"What Can Management and Labor Expect of Job Evaluation?" was discussed by Dean Asa Knowles, member executive committee A.S.M.E., of the Rhode Island State College, at the May 15 meeting held at the Worcester Polytechnic Institute, Worcester, Mass. Dean Knowles defined job evaluation as an instrument to find out what is expected of a job holder and the pay that is equitable for the job. He stressed the time and patience and cooperation required from all concerned to set it (?) up. He said that management should know and be ready to give the answers to their employees on questions asked about it, and pointed out the value to management and labor of having such a system. Seventy-five members and guests heard the talk.



LOOKING IT OVER

(Alf Hansen, *left*, chairman, San Francisco Section, and M. A. Hinrichs.)

Student Branches

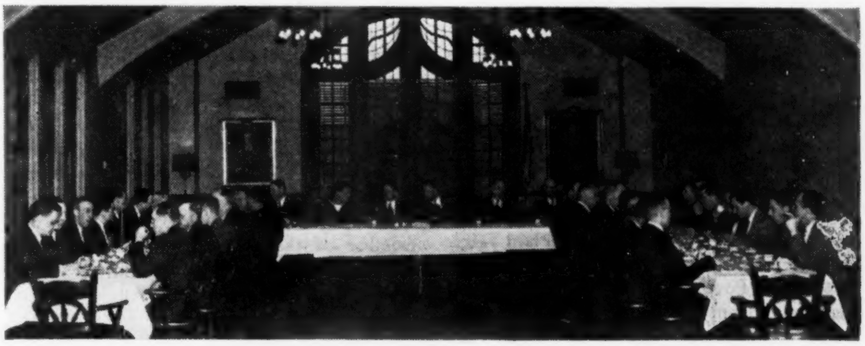
JOINT MEETING OF CENTRAL INDIANA SECTION AND PURDUE STUDENT BRANCH AT PURDUE UNIVERSITY, MAY 11

(*Left to Right:* D. P. Morse, vice-chairman, Central Indiana Section; R. C. Perkey, toastmaster, Purdue Student Branch; M. E. Bechtold, chairman, Central Indiana Section; Prof. H. L. Solberg, head, School of Mechanical Engineering, Purdue University; and Ferdinand Jehle, secretary-treasurer, Central Indiana Section.)

A.S.M.E. Student Branch at Purdue Holds Joint Meeting With Central Indiana Section

A JOINT meeting was held on May 11 with the Central Indiana Section, at the mechanical-engineering building. The laboratories of the school of mechanical and aeronautical engineering were open for inspection in the afternoon. Dinner was served in the west faculty lounge of Purdue Memorial Union, and the members and guests then went to the mechanical-engineering building to hear Prof. H. L. Solberg, head of the school of mechanical and aeronautical engineering, discuss briefly the general research program being carried on under his supervision. He was followed by N. Kulik who spoke on "The Evolution of Jet and Rocket Propulsion Devices," and Dr. C. F. Warner on "Engineering Application of Infrared Photography." Both of these speakers are members of the staff of the school of mechanical engineering.

R. C. Perkey, engineer, Studebaker Corporation, was the speaker at the May 29 meeting in the mechanical-engineering building. He discussed "The Fundamental Principles of Design and Construction as Applied in a Radial Engine," and supplemented his talk with an actual Studebaker-built Wright engine that is used in the B-17 bomber. Mr. Perkey elaborated on the light construction of this engine, and said that most of the engine's 8000 parts are interchangeable. He concluded his talk with the remark that enough power is developed so that each piston on its upstroke has a lifting power of over 15 tons.



DINNER MEETING AT WHICH MEMBERS OF THE CENTRAL INDIANA SECTION WERE GUESTS OF THE PURDUE STUDENT BRANCH

University of California Branch

At the May 11 meeting in the engineering building, L. R. Morris, a representative of the National Carbon Company, San Francisco, Calif., was the speaker. Mr. Morris illustrated his talk with a kodachrome sound film entitled "Carbon-Black Treasure," which dealt with carbon electrodes.

California Institute of Technology Branch

Dr. Martin Summerfield, Research Fellow in Aeronautics, was the speaker at the April 25 meeting. He gave a talk on jet propulsion to student members, faculty members, and their wives. With the aid of some thermodynamics and mechanics Dr. Summerfield showed the limitations and advantages of rocket and jet propulsion very conclusively. An informal discussion followed.

University of Cincinnati Branch

On May 2 in the Student Union building two Westinghouse films were shown, the first entitled "What Is Electricity," and the second, "Electronics at Work."

University of Idaho Branch

On May 3 the Branch made its annual field trip to the Spokane Army Air Depot where the machine shops, heating plant, motor repair shops, testing department, instrument repair, and other departments were visited. In the afternoon an inspection trip was made to the Spokane city water-pumping plant, and the pulp and paper mill where the making of paper was followed from the log to the finished product. On the following day, May 4, the Branch visited the Grand Coulee Dam where they examined the dam, power plants, and switchyards. The power plant and dam at Long Lake, Wash., were also visited during the trip.

A joint dinner meeting was held on May 11 with the Spokane Section A.S.M.E., and students from Washington State College and Gonzaga University. Ira Jacobson was awarded first prize of a one-year A.S.M.E. junior membership which he will receive upon graduation, for his paper entitled "Nitriding of Steel." Second prize went to Bill Abbott for his paper on "Powder Metallurgy." Both prize-winners are attending the University of Idaho. This meeting, the first since the beginning of the war, is an annual affair which is sponsored by the Spokane Section, and ordinarily includes all engineering student sections in the Pacific Northwest.

At the May 15 meeting the following officers were elected for the coming year: Donald Camp, chairman; Ronald Kilborn, vice-chairman; John Pointer, secretary and treasurer; and Prof. Henry F. Gauss, honorary chairman.

Illinois Institute of Technology Branch

A special meeting was held May 5 for the purpose of selecting a paper for presentation at the Northwestern Conference. Roy Sahlstrom presented a paper on "Jet Propulsion," and John Erickson one on "Increasing the Efficiency of Gas-Turbine Cycles." Both papers were interesting and informative, and the voting was close. Mr. Erickson was selected as the winner.

At the meeting on May 25, W. S. Bodinus, manager of the Chicago Office of the Carrier Air Conditioning Corporation, was the guest speaker. His subject, "The Weathermaster System of Air Conditioning," was illustrated

with slides and was enjoyed by the audience. A brisk discussion period followed.

Iowa State College Branch

A meeting was held on April 10 in the south ballroom, Memorial Union, with the student branch of A.S.C.E. The program feature was a movie on war expansions made by the U. S. Steel Company.

On April 24 the Branch attended a program of the aeronautical engineers and heard Charles Byrne of Solar Aircraft Corporation speak on the importance of either a salesmanship, accounting, or legal background in the engineer's education. The Branch then returned to their meeting room and heard a paper entitled "Gas Turbines, Yesterday and Tomorrow" by Myron Anderson, president, who will represent the Branch at the A.S.M.E. meeting in Chicago in May.

A picnic was held at Brookside Park on May 3 to which all the mechanical engineers on the campus were invited. A faculty-student softball game was held in which the students were able to hold the "profs" to a 4-all tie. The success of the picnic was a result of the fine work of chairmen Bothwell, Depuy, and their aides.

Kansas State College Branch

At the May 3 meeting in the engineering building, the following officers were elected for the coming year: H. O. Criss, president; Claude Shelor, vice-president; Mary Helen Rood, secretary; and Hank Brandes, treasurer. Prof. A. J. Mack will act as the new faculty sponsor. Following the meeting a picnic was held in the city park.

Lafayette College Branch

Election of officers for the coming year was held at the May 23 meeting in Pardee Hall, with the following results: James T. McShane, president; Edgar A. Fayer, vice-president; Daniel J. Bustraan, secretary, and Judson H. Merl, treasurer. Paul B. Eaton was re-elected honorary chairman for the new term.

Marquette University Branch

An interesting talk on "Power-Plant Engineering" was given by M. K. Drewry, Wisconsin Electric Power Company, at the May 19 meeting, held in the student room. The lecture was illustrated with slides of the Port Washington power plant. A picnic was planned to which all members were invited.

University of Maryland Branch

The first meeting of the summer quarter was held on May 1, with members of the A.S.C.E., A.S.Ch.E., and A.I.E.E. Edward Larson, secretary of the National Society of Professional Engineers, was the speaker, and his subject, "Professionalism and Engineers in Industry," was of great interest, as was evidenced by the discussion period of an hour and a half which followed.

A second meeting was held on May 29 jointly with members of the A.S.C.E., A.S. Ch.E., and A.I.E.E. Col. C. E. Davies, secretary A.S.M.E., spoke on "The Growth of the Engineer." His talk was of great interest and the members were grateful to him for an absorbing as well as entertaining program.

New York University Branch

On April 15 a meeting was held at Lawrence house, when an interesting talk on gas turbines, illustrated with slides, was given by Paul R. Sidler, member A.S.M.E., authority on gas turbines, whose article, "Gas-Turbine Locomotive for Main-Line Service," was published in MECHANICAL ENGINEERING, November, 1944.

At the meeting on April 23, a 45-minute film was shown on turret lathes, and a shorter one on electronics. Following the showing of the films, a discussion period was held.

Dr. Sergei Korff, professor of physics, New York University, spoke at the meeting on May 15, on instruments and balloons used in cosmic-ray research, and on the nature of cosmic rays. His talk was most interesting and evoked a lively discussion.

On May 31 Ole Singstad, chief engineer of the Port of New York Tunnel Authority, told of the construction and operation of the Queens-Midtown, Lincoln, and Holland tunnels. He delivered a very absorbing 2-hour talk illustrated with slides. Thirty members of the A.S.C.E. were present.

Ohio State University Branch

The first meeting of the spring quarter was held on March 30 at Robinson laboratory, when part of the constitution was read, pertaining to the purpose, committees, and officers of the organization. The purposes and advantages of the national meetings were discussed.

On April 6 the Branch had as their guests members of the A.S.Ch.E., when a film entitled "Magnesium, the Miracle Metal" was shown.

Prof. Harvey E. Nold, of the department of mine engineering, was the speaker at the April 20 meeting. His talk was on "The Engineer and His Profession."

At the April 27 meeting Prof. John Edwards of the department of physics, gave a talk on "X Rays, Sources Other Than the Usual Sources."

At the May 4th meeting, a film entitled "The Birth of a B-29" was shown.

On May 11 at Robinson laboratory Prof. Oscar D. Rickley of the industrial-engineering department, spoke on salvaging of critical materials from machine steels, mainly the high-speed tungsten steels. Professor Rickley is a member of the National Critical Materials Conservation Commission pertaining to tungsten. A question period followed.

Pennsylvania State College Branch

On May 8 a meeting was held in the engineering building "D" to discuss various subjects, among them the opportunities for employment in foreign countries on a reconstruction job, and improvements to be made in the engineering curriculum. Suggestions were made for future visits to factories on inspection tours, and plans presented for faculty members to be guest speakers at future meetings.

University of Pennsylvania Branch

On April 11, at the Christian Association building, a joint meeting was held with the junior section of the A.S.M.E.; also in attendance were student members from Swarthmore and Villanova colleges. The program consisted of a talk by D. N. Meyers, mechanical engineer, P-V Engineering Forum Corporation, entitled "Mechanical Problems in Helicopter Design." Mr. Meyers illustrated his talk with slides and concluded with technicolor movies of "Helicopters in Action." Of special interest to the audience was the fact that Mr. Meyers is a recent graduate of the mechanical-engineering department of the Towne School, University of Pennsylvania.

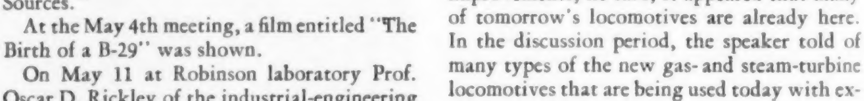
Rensselaer Polytechnic Institute Branch

At the meeting on April 27 the formal announcement was made of the results of the election of officers held on March 22 and 23: Irve Kosecoff, chairman; Ian Grad, vice-chairman; Carl Morrison, treasurer, and Robert Wick, secretary.

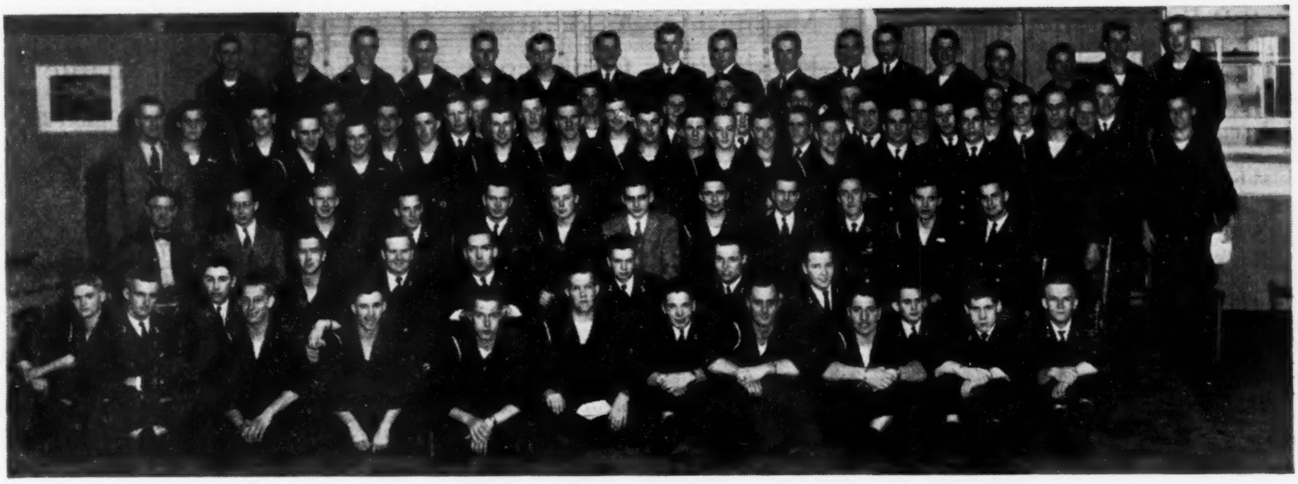
The guest speaker was James Partington, member A.S.M.E., manager, engineering department, American Locomotive Company, whose subject was "Tomorrow's Locomotives." Mr. Partington discussed the future possibilities of the steam, electric, and Diesel-electric locomotives. He told of the various methods for improvement that are already in use in helping the war effort. Because of these improvements, he said, it appeared that many of tomorrow's locomotives are already here. In the discussion period, the speaker told of many types of the new gas- and steam-turbine locomotives that are being used today with excellent results.

Rose Polytechnic Institute Branch

On May 21 the Branch made an inspection trip to the Dressler power plant. This plant is a central power station which furnishes electricity to Terre Haute, Ind., and several smaller towns in the district. The plant has a capacity of 175,000 kw furnished from three 25,000-kw and two 50,000-kw turbogenerators. At the time of the inspection the company was



A.S.M.E. STUDENT BRANCH NORTHEASTERN UNIVERSITY, BOSTON, MASS.
(*Seated, front row center:* Prof. F. A. Stearns, adviser.)



A.S.M.E. STUDENT BRANCH AT TUFTS COLLEGE, MEDFORD, MASS.

installing another 50,000 kw unit and also reblading one of the 25,000-kw units, which added to the interest of the trip. This plant is unique in that it has all of its raw materials available at the plant. The trip, which was arranged by Prof. Carl Wischmeyer, was interesting and instructive.

Tufts College Branch

On April 18 a membership drive was begun with an informal meeting. W. S. Young stressed the advantages of membership in the Society, and Prof. E. MacNaughton addressed the branch on the varied problems of the young college graduate in industry. A film showing the various duties of petty officers of the Artificer-Branch engine-room force was presented.

Student papers were presented at the meeting on May 1 in Robinson Hall, for awards and later participation in the intercollegiate competition. A paper entitled "Mobile Refrigeration," by V. Quackenbush, was awarded first prize. "Types of Helicopters," by J. Wisnik, received second prize. Other papers were: "Analysis and Effects of Manifold Heating," by R. D. Smith; "Plastics by Monsanta," by H. G. Payne, and "High-Speed Indicators," by W. L. Ramer.

A combined engineering-society group sponsored the meeting on May 9 at the chemistry building, when W. M. Hall of Charles T. Main, Inc., was the guest speaker. Mr. Hall, widely known in engineering circles for the work he has done on both government and private dam construction in this country and abroad, spoke on "Hydroelectric Power." He discussed the phases of the subject from choosing the site of dam construction to electrical equipment used in power transmission. The lecture was attended by 125 members and visitors.

Yale University Branch

The weekly meetings of the Branch were held as scheduled from April 18 to May 19, inclusive, and each week five 10-minute speeches were given by student members. Among these talks were: "Earliest American," by W. M. Braithwaite; "The Blood You Donate," by R. B. Dowdell; "The Effects of Leadership and Morale on Seapower," by J. J. Gallow; "Specifications Department," by W. H. Meeker, IV; "The Miracle of Hickory," by E. G. Mudarri; "Guides to Discussion," by R. P. Carroll; "T. Lincoln," by R. C. Tucker; "Jack and Heintz," by Arthur Berger; "Birds and the Wing," by G. J. Crowley; "Superwood," by Merrill Holpert; "Plastics," by R. C. Ehrhardt; and "Survival at Sea," by E. F. Mioduszcwski. Chairman John Prisloe gave an excellent nontechnical speech entitled "As I Look Back Now," dealing with his college days. T. E. Schultz presented his report of the A.S.M.E. annual conference of New England student branches held at M.I.T. in Boston, Mass., on May 13. The Yale representatives upon this occasion were T. E. Schultz and R. C. Tucker.

Other papers heard on engineering subjects during April and May were: "Postwar Private Plans," by E. D. Clarke; "What People Expect in Postwar Automobiles," by W. J. McFarland; "Odor Control," by W. Gloss; "Tugboating," by J. Hassell; "Trade Unions for Engineers," by S. L. Sulis; "Space and Time," by Irving Ross; "Flight to the Stratosphere," by R. Sinclair; and "Automobiles—After 1945 What?" by E. Pommer.

A joint meeting was held on June 1 with the A.I.E.E. at Strathcona Hall, at which senior members of both societies of the New Haven district were in attendance. G. E. Pendray, of the Westinghouse Electric Corporation, spoke on "Jet Propulsion." Because of his long experience in working with jet motors, his personal experiences added interest to his discussion.

Commemorates Stevens' 75th Anniversary

TO celebrate the 75th anniversary of Stevens Institute of Technology, Hoboken, N. J., the Alumni Association issued on Alumni Day, May 26, an anniversary volume on the history and achievements of the Institute. This volume expresses the admiration of engineers of today for the foresight of the founders of Stevens in laying down in 1870 a program of basic, unspecialized engineering training which has proved itself in preparing men for subsequent specialism in all branches of the profession, and asserts that an unspecialized plan of study meets the needs of 1945 and of the now-foreseeable future. This anniversary book is dedicated "to the men of Stevens serving their country" and is being distributed to members of the Alumni Association, to faculty, students, and friends of the college. It points out that in three-quarters of a century the college has had only three presidents. The first president, Dr. Henry Morton, vice-president A.S.M.E., 1882–1884, served 32 years, and his successor, Dr. Alexander Crombie Humphreys, President A.S.M.E., 1927, served 25 years. Dr. Harvey N. Davis, past-president A.S.M.E., 1938, was inducted as the third president of Stevens in 1928, and the anniversary volume terms him "a noted scientist and a national and personal force in modern education."

The book recounts the history of the Alumni Association which was organized on July 1, 1876, with 25 members and now has over 4000.

Princeton to Offer Graduate Program in Aeronautics

THE School of Engineering, Princeton University, has announced that it will launch the first formal graduate teaching program of its Department of Aeronautical Engineering on Nov. 1, 1945.

The curriculum to be offered, while covering the fundamentals established as basic for such graduate work, will emphasize those phases of aeronautical science which have been radically advanced during the war period. Fundamentals will include the study of aerodynamic theory, vibrations, and elasticity. In addition, full courses are to be offered in helicopter design and the design of modern high performance aircraft. Special consideration is to be given to such topics as the aeronautical applications of jet propulsion and gas turbines and modern techniques of flight testing and structural research.

The permanent staff of the department, which was organized in 1942, includes Prof. Daniel Sayre, chairman, Prof. Alexander Nikolsky, and Asst. Prof. Johann F. Ludloff. A fourth permanent faculty member, a specialist in high-performance airplane design, is soon to be appointed. In addition, a number of outstanding specialists are to be enlisted as visiting lecturers in their respective fields.

S.P.E.E. Council Meets at Pittsburgh

BECAUSE of the restrictions on travel the annual convention of the Society for the Promotion of Engineering Education was canceled but a meeting of the Council of the Society was held at Pittsburgh June 1 and 2.

Since there could be no election under the constitution, the officers hold over. President H. S. Rogers of Brooklyn Polytechnic Institute continues as president of S.P.E.E. Dean N. W. Dougherty of the University of Tennessee and Dean H. M. Crothers of South Dakota State College are first and second vice-presidents, respectively. Dr. F. L. Bishop of the University of Pittsburgh is secretary and James S. Thompson, president, McGraw-Hill Book Co., New York, is treasurer.

The shortage of engineers in colleges and in industry, military training which would recognize the contribution of the colleges, research, administrative problems, and a radical revision of the constitution with change of the society's name were important topics discussed by the council.

H. P. Hammond Receives Lamme Medal

Dean Harry P. Hammond, member A.S.M.E., of the School of Engineering, Pennsylvania State College, received the Lamme Medal for distinguished service to engineering education. Dean Hammond was assistant director of the S.P.E.E. Investigation of Engineering Education and is now chairman of the committee established to accredit technical institutes.—R.L.S.

Stevens Initiates Seminars for Executives

ON May 22 a group of 11 industrial executives attended the opening session of a series of seminar meetings especially designed for them by the War Industries Training School of Stevens Institute of Technology, Hoboken, N. J.

The course is entitled "The Human Element in Industry" and represents a unique departure in the field of industrial training because it is geared to members of the management group to help them solve their problems by discussion.

Because of the informal nature of the new course, which consists of a series of seven lectures and discussion meetings, preceded by dinner at Castle Stevens on the campus, it is known as the "Executives Club." Dr. Harvey N. Davis, president of Stevens, was host to the executives at the first dinner. Dr. Frederick J. Gaudet, associate professor of industrial psychology at the Institute, is the chairman of the seminars. At later meetings a few guest lecturers will be invited to participate. Among the subjects to be covered in future sessions are analyses of labor turnover; a discussion on the measurement of morale of workers and a critical evaluation of methods of obtaining good morale; the training of supervisory workers; problems of reconversion, including transfer procedures, training of workers, the work done by the Veterans Administration guidance centers in placing men, and the mental adjustments required of the normal, the operationally fatigued, and neurotic worker.

Magnesium Association Holds Press Conference

AT A press conference held in New York, May 15, 1945, T. W. Atkins, newly appointed executive vice-president of The Magnesium Association, said that the present membership of the association was made up of 48 companies engaged in the production, manufacture, fabrication, and processing of magnesium in the United States and Canada.

The Magnesium Association is a nonprofit organization formed to develop the use and acceptance of magnesium and its products. Officers of the association, in addition to Mr. Atkins are: Edward S. Christiansen, president of The Magnesium Company of America, Inc., Chicago, Ill., president; C. C. Loomis, president of the New England Lime Co., Canaan, Conn., vice-president; Clayton E. Larson, operations manager of the White Metal Rolling and Stamping Corporation, Brooklyn, N. Y., treasurer; and James B. Westcott, counsel. Headquarters of the association are at 30 Rockefeller Plaza, New York, N. Y.

Three Papers on Fuel Economics Available

THREE papers constituting a panel discussion of the subject, "Fuel Economics Affecting Power-Plant Design," presented at a joint meeting of the Steam Power and Fuels Divisions of the Metropolitan Section of The American Society of Mechanical Engineers, in New York, N. Y., on Feb. 6, 1945, have been published in pamphlet form for distribution by the Fairmont Coal Bureau, 122 East 42nd St., New York 17, N. Y.

The papers comprising the panel are: "A Renaissance in Power Plants," by J. E. Tobey, member A.S.M.E., director, Fairmont Coal Bureau; "Fuel Economics Should Affect Design of Combustion Equipment," by Earl C. Payne, member A.S.M.E., consulting engineer, Consolidated Coal Company, New York, N. Y., and "The Whole of Fuel Engineering Economics Is the Sum of All Its Parts," by Graham Granger, member A.S.M.E., consulting engineer, Koppers Coal Division, Eastern Gas and Fuel Associates, New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

GRADUATE MECHANICAL ENGINEER from first-class American university, age 29, married, excellent health. Eight years' experience in small and medium mechanisms, fire-control mechanism, and mathematical analysis. Have handled to 300 men. Interested in permanent position west or southwest U. S. Foreign position acceptable if good proposition. Me-910.

GRADUATE MECHANICAL AND ELECTRICAL ENGINEER, twenty-five years of operation, maintenance, and development work including personnel training. Capable supervising large numbers of men in trades or graduate engineers in project preparation and development work. Excellent health, good organizer, manager. Permanent location desired. Me-911.

MECHANICAL ENGINEER, M.M.E. Most recently research and development engineer on hydraulic machinery and equipment. Previous experience as marine development and production engineer of machinery and power-plant equipment. Me-912.

PROJECT-DESIGN ENGINEER, graduate mechanical, 31, four years chemical plant and equipment design, five years varied engineering and mechanical design. Can best serve in position involving design, construction, and maintenance. Prefer chemical or process plant. Me-913.

MECHANICAL, INDUSTRIAL, AND CIVIL ENGINEER, executive, 40, Army Officer for eighteen years, consulting and executive experience in management, sales, plant layout, construction, production methods. Desire position abroad, preferably Latin America. Me-914.

GRADUATE ENGINEER, registered, 32, ten years' experience as process and project engineer for petroleum and chemical plants. Desires position as consulting or assistant chief engineer. Prefer West Coast. Will consider foreign assignment. Me-915.

[1] All men listed hold some form of A.S.M.E. membership.

PLANT ENGINEER, age 45, married, New Jersey Gold Seal license, New York City license both steam power, refrigeration—sixteen years experience as chief engineer, now chief engineer meat packing-house. Me-916.

POSITIONS AVAILABLE

WORKS MANAGER for manufacturing plant employing about 1500 people. Company engaged in manufacturing of office appliances and small parts. Should have held similar position for number of years. $25,000–$30,000 year. Middle West. W-5404C.

METHODS AND TIME-STUDY ENGINEERS. Must be capable of conducting studies to ascertain time spent by workers on completion of particular duties, calculate amount of time, number of employees, system and methods of doing job. Make recommendations and devise methods on plant layout to improve plant efficiency and eliminate waste. Salary open. Maryland. W-5415.

CHIEF DRAFTSMAN with mechanical-engineering background and capable of handling large force of draftsmen, designing special machinery required. $7000 a year. Tennessee. W-5422(*a*).

INDUSTRIAL DESIGNER with wide experience in field of industrial design. Must be capable of making preliminary and final renderings, for submission to clients, of mechanical objects from small appliances to large industrial machines, make mechanical and explosion drawings to explain design and operation of devices to clients. Must work on drawing board. Permanent with good opportunity for advancement. $5000 a year to start. New York, N.Y. W-5431.

INDUSTRIAL ENGINEER, 28-45, college education, industrial engineering preferred, with four years' experience in work-simplification techniques, time study, correcting poor manufacturing practices, etc. $5000–$6000 year. Upstate New York. W-5433.

PLANT ENGINEER capable of supervising draftsmen, millwrights, welders, and all types of trade people for building maintenance, also plant machine shop manufacturing shells and rocket bodies. Should have good personality and have executive ability. Write giving names of business references. $6000–$7000 year. Delaware. W-5445.

SUPERINTENDENT with good experience and background in refractories manufacture. Work involves actual plant-operating supervision. $5000–$6000 a year. Middle West. Interviews, New York, N.Y. W-5466-C.

INDUSTRIAL ENGINEER well-versed in industrial-engineering activities and with sufficient experience to direct everyday efforts of several junior engineers. Must assume responsibility and obtain results. Also need some junior industrial engineers who majored in industrial engineering with several years of practical experience. Salaries open. Georgia. W-5475.

ASSISTANT TO CHIEF MECHANICAL ENGINEER for large firm of consulting architects and engineers. $7500 a year. Connecticut. W-5509-B.

ENGINEERS. (*a*) Industrial engineer with broad training and experience, including manufacturing processes, technical problems, etc. (*b*) Industrial promotion engineer with less emphasis on sales ability in which engineering training might not be necessary. $6000–$6500 year. New York State. W-5511.

CHIEF ENGINEER AND VICE-PRESIDENT, 40–45 preferred, mechanical graduate, with considerable experience in heavy machine-shop work and particularly in product development. Company manufactures stokers, planers, special forgings, etc. $10,000–$15,000 year. Ohio. W-5523-D.

SALES ENGINEER for sales and distribution of automotive oil filters, particularly for internal-combustion engines. $5000–$6000 year. Headquarters, Rhode Island. W-5525-B.

RESEARCH ENGINEER for very large shipyard. Must have some background and experience in ship construction, engines, and general machinery. $15,000 year. Connecticut. W-5529.

SALESMAN thoroughly acquainted with construction machinery such as concrete mixers, air compressors, rock-crushing plants, paving equipment, pumps, and Diesel engines. Must have knowledge of Spanish. $6000–$9000 year. Write giving full information of education, experience, references, and attach photograph. Venezuela. W-5530.

GENERAL MANAGER with considerable experience taking charge of a manufacturing company, to revamp woodworking factory and take over supervision of sales, etc. Plant employs about 1000 men. $9000 year. Southwest. W-5532.

ELECTRICAL ENGINEER, graduate, with several years' experience in industrial plants. Must be familiar with generators, motors, and electrical equipment. Permanent. Location, Massachusetts. W-5540.

Drafting Room Practices to Be Co-Ordinated by Army, Navy, A.S.A.

ARMY, Navy, and industry representatives have met with the American Standards Association to form a committee that will tackle the problem of more completely co-ordinating drafting room practices. The Armed Forces and industry have much to gain from the job through the speeding up of production resulting from a single procedure in respect to drawings. Initia production and design changes will be simplified by standardization of form and interpretation. This move to develop uniform standards is backed by a joint directive of the secretaries of War and Navy to their departments.

The Army and Navy have already set up committees within their jurisdiction to unify the practices in the various branches of the Services and have authorized the American Standards Association to co-ordinate this activity with industry.

William A. Bischoff, of Bell Laboratories, is chairman of the A.S.A. Executive Committee which will direct the work of the War Committee. Also on the Executive Committee are T. G. Crawford of General Electric Company representing industry, Col. B. L. Neis representing Army, and Commander R. L. DeGroff representing the Navy. The War Committee of the A.S.A. under the same chairmanship is made up of representatives of the Armed Forces and industry as follows: Frank H. Rogan, aircraft; J. G. Perrin, aircraft engine; W. L. Barth, automotive; F. P. Anderson, electrical; A. J. Stromsted, marine engineering; Charles A. Ward, Jr., naval architecture; F. H. Kuhl, public utilities; Elmer J. Bryant, machine tools; William Johnson, machinery. Each will act as a clearing house for the approval of standards and for the forwarding of information and suggestions to the War Committee.

A joint Army-Navy committee has already outlined the initial scope of much of the job ahead which will deal with the following subjects in the fields of civil, mechanical, electrical, aeronautical, and marine engineering: (1) Abbreviations; (2) methods of indicating and specifying threads; (3) method of lettering; (4) drawing forms and sizes; (5) graphical, diagrammatic, and schematic symbols; (6) methods of indicating and specifying materials; (7) methods of indicating and specifying finishes; (8) methods of dimensioning and indicating tolerances; and (9) methods of numbering drawings.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after July 26, 1945, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

NEW APPLICATIONS

For Member, Associate, or Junior

ALDRIDGE, C. FOSTER, Rochester, N. Y.
ALLEN, AUBREY C., Southboro, Mass.
ASKREN, J. A., Decatur, Ill.
BAKER, EDWARD G., New York, N. Y.
BEATTY, ROBERT J., Columbus, Ohio
BECKMAN, JOHN GEORGE, Evansville, Ind.
BENTON, L. A., Newton, Pa.
BERNHARDT, CHARLES H., Bell, Calif.
BERNTSEN, CARL B., Staten Island, N. Y.
BERRY, EDWARD J., Edgewood, Providence, R. I.
BISSELL, WILLIAM S., Los Angeles, Calif.
BLACKMAN, STEWART, Washington, D. C. (Rt)
BLANTON, BURT C., Dallas, Texas (Rt & T)
BOLANDER, WARREN WALTER, Lyndhurst, N. J.
BORGEL, BERNARD F., Erie, Pa.
BREMMER, JOHN L., Warrenton, Mo.
BREWER, ALLEN F., Avon-by-the-Sea, N. J. (Rt)
BRUST, GEORGE A., St. Paul, Minn.
CAMPBELL, JOHN A., New York, N. Y.
CATTLEY, W. E., Weston, Ontario
CHAPMAN, E. CORBIN, Chattanooga, Tenn.
CHRISTIAN, JOHN C., Jr., Seattle, Wash.
CLARK, WILLIAM GIBSON, Chicago, Ill.
COLEMAN, W. L., El Dorado, Ark.
COLIBRARO, DANIEL, Collingswood, N. J.

Comroe, Irving H., River Edge, N. J.
Coxon, Wilfred R., Hopewell, Va.
Crompton, E. E., Erie, Pa.
Davies, Robert H., Cleveland, Ohio
Dudas, John, Jr., Clifton, N. J.
Eberle, James W., Scotia, N. Y.
Elliott, Leslie E., Toronto, Ontario
Engberg, Ralph E., Brooklyn, N. Y.
Frederick, R. W., State College, Pa.
Fyles, Cleveland, Bethel, Vermont
Gagnon, Alfred J., West Hempstead, N. Y.
Gangi, Salvatore, Brooklyn, N. Y.
Giering, P. L., Great Neck, N. Y.
Glassie, D. C., Washington, D. C.
Goldberg, Charles K., Chicago, Ill. (Rt & T)
Graham, Lloyd McConnell, Tacoma, Wash.
Grant, Irving G., Raleigh, N. C. (Rt & T)
Gross, F. R., Akron, Ohio
Gruett, LeRoy E., Milwaukee, Wis.
Gulick, Horace S., Watertown, N. Y.
Gustav, C. F., New York, N. Y.
Hadley, Robert C., Denver, Colo. (Rt & T)
Hagerty, Francis W., Cohasset, Mass.
Hague, Robert, Kingsport, Tenn.
Hartwell, Cushman, Marion, Va. (Rt)
Heftler, Paul, Detroit, Mich.
Huston, John I., Oaklyn, N. J.
Johnson, H. E., Chicago, Ill.
Jones, Cecil E., Lima, Ohio
Kane, William R. (Capt.), c/o Postmaster, San Francisco, Calif.
Kaufelt, Curtis L., Milwaukee, Wis.
Keller, Ralph, Oneida, N. Y.
Keppelman, Henry S., Reading, Pa.
King, Douglas H. (Capt.), Detroit, Mich.
King, Glenn L., Iago, Texas
Kirk, Walter B., East McKeesport, Pa.
Kirkpatrick, F. M., Erie, Pa. (Rt & T)
Klaus, Albert Joseph, Jersey City, N. J.
Kottcamp, John P., Jr. (Major), Aberdeen, Md.
Kuechler, Gustave H., Queens Village, N. Y.
Kuehl, Thomas J., Chicago, Ill.
La Gambina, Joseph C., Malverne, N. Y.
Lancaon, Juan S., Honolulu, T. H. (Rt & T)
Lindsay, David, Wadsworth, Ohio
Littig, J. S. (Lieut.), Long Beach, Calif.
Ludolph, Karl H., New York, N. Y.
Lutz, Lawrence G., West Hempstead, N. Y.
Matlin, Charles, West Allis, Wis.
May, L. E., New York, N. Y.
McCaffery, Francis X., New York, N. Y.
McClure, Samuel S., Vineland, N. J. (Rt & T)
Menke, John Roger, New York, N. Y.
Metcalfe, Gordon S., Chicago, Ill.
Miley, Frederick B., New York, N. Y.
Montgomery, O. D., E. Pittsburgh, Pa.
Morehiser, John E., Jr., New Orleans, La.
Nazzaro, Rocco M., Paterson, N. J.
Newby, W. M., Niagara Falls, Ontario
Norris, Alfred G., Berkeley, Calif. (Rt)
Patterson, Anthony R. (Capt.), c/o Postmaster, New York, N. Y.
Pettit, Jack L., Bloomfield, N. J. (Rt)
Pitt, Rayleigh St. C., Nedlands, Western Australia
Quist, Stettler H., Richland, Wash.
Rankin, Andrew W., Schenectady, N. Y.
Rein, Francis B., Monroe, La.
Renn, William J., Jr. (Lieut. Col.), Jenkintown, Pa.
Richardson, Robert W., New York, N. Y.
Robinson, G. Elliott, Buffalo, N. Y.
Rodriguez, Charles, New York, N. Y.
Ryan, John E., Scotia, N. Y.
Samson, James B., Angus, Scotland
Siefert, George C., New York, N. Y. (Rt)
Siler, William, Anderson, Ind. (Rt)
Sipko, Michael, Cleveland, Ohio
Skonberg, Elmer A., Louisville, Ky.
Slaton, Gunther, New York, N. Y.
Smith, Alfred R., Forest Hills, N. Y. (Rt)
Smyth, Sigurd (Lieut.), Cliffside Park, N. J.
Snyder, George L., Downington, Pa.
Spalding, Ronald H., Jr. (Ensign), c/o Fleet Post Office, San Francisco, Calif.
Stalker, D. F., Oakland, Calif.
Studhalter, Walter R., Lubbock, Texas
Sutcliffe, J. B., Haifa, Palestine
Takesuye, Thomas, Manchester, N. H.
Thornton, Harry E., Plainfield, N. J.
Thuli, Alvin J., Jr., Caletones-Rancagua, Chile, S. A.
Vang, Harold K., Philadelphia, Pa.
Vinson, A., Mahebourg, Mauritius Island (Rt & T)
von Maltitz, H. K., Chicago, Ill.
Von Rotz, Robert, Manhasset, N. Y. (Rt & T)
Walsh, Walter John, Malden, Mass.
Wellhausen, Charles Richard, Hackensack, N. J.
Westlake, W. Gladden, Hopewell, Va.
Williams, Clyde, Columbus, Ohio
Wilson, John A., Cranston, R. I. (Rt & T)
Wyder, Carl G., Hackensack, N. J.

CHANGE OF GRADING

Transfers to Fellow

Blumberg, Leo, Wilmington, Del.
Brinley, Charles E., Philadelphia, Pa.
Dickerman, W. C., New York, N. Y.
Ennis, Joseph B., Paterson, N. J.
Haller, Louis G., Johnson City, Tenn.
Kiefer, Paul W., New York, N. Y.
Kniskern, Walter Hamlin, Petersburg, Va.
Miller, Alten S., Princeton, N. J.
Nystrom, K. F., Milwaukee, Wis.
Ripley, C. T., Chicago, Ill.
Seaton, Dean Roy A., Manhattan, Kansas
Shoemaker, Guy T., Kansas City, Mo.

Transfers to Member

Avery, Jasper W., Cleveland, Ohio
Boswell, William L., Rahway, N. J.
Clark, Leo E., Westfield, N. J.
Cox, Edward L., Washington, D. C.
DeCenzo, Elbert P., Detroit, Mich.
Esselman, R. B., San Gabriel, Calif.
Fine, Maurice Edward, Norfolk, Va.
Freeman, Myron F., Needham, Mass.
Johnson, B. J., Richmond, Va.
LaForge, Robert M. (Major), Alexandria, Va.
Obert, Edward F., Evanston, Ill.
Reinhart, Chauncey O., Roselle, N. J.
Reiss, Andrew E., Kenmore, N. Y.
Streid, Dale D., Marblehead, Mass.
Wills, J. G., Oakmont, Pa.

Transfers from Student-Member to Junior......90

A.S.M.E. Transactions for June, 1945

THE June, 1945, issue of the Transactions of the A.S.M.E., which is the *Journal of Applied Mechanics*, contains:

TECHNICAL PAPERS

A Simplified Method of Determining Hoop Stresses in Fan Rotors, by G. F. Lake
The Effect of Transverse Shear Deformation on the Bending of Elastic Plates, by Eric Reissner
Distribution of Tooth Load Along a Pinion, by H. Poritsky, A. D. Sutton, and A. Pernick
Load Distribution of Reduction Gears, by F. M. Lewis
Experimental Investigation of Turbulence Diffusion—A Factor in Transportation of Sediment in Open-Channel Flow, by E. R. Van Driest
Dynamics of an Elastic Bar, by O. R. Wikander
Stresses in a Cylindrical Shell Due to Nozzle or Pipe Connection, by G. J. Schoessow and L. F. Kooistra
Fatigue Tests of Airplane Generator Brackets With Special Reference to Failure of Screw Fastenings, by A. M. Wahl

DISCUSSION

On previously published papers by R. O. Fehr, E. R. Parker, and D. J. DeMicheal; J. N. Goodier and M. V. Barton; and A. C. Hagg

BOOK REVIEWS

Necrology

IT is urged that the Society be notified promptly of the deaths of members and that the date of death be given for announcement in MECHANICAL ENGINEERING. Complete memorial biographies are published in the Society Records (Section Two of Transactions), and relatives, business associates, and Society officers and members are requested to send newspaper clippings or information in any other form which will be useful in the preparation of such biographies. A special biographical data sheet for supplying complete details will be furnished by the headquarters office upon request.

Billow, Clayton O., March 19, 1945
Boetcher, Hans N., April 19, 1945
Davis, William J., Jr., February 18, 1944
Dewey, Fred S., May 27, 1945
Dibert, Herbert M., April 7, 1945
Evans, Henry S., February 25, 1945
Hulett, Frank E., August 27, 1944
Keane, Arthur F., November 21, 1944
Knapp, Vernon W., May 12, 1945
Olson, Charles W., November 8, 1944
Pinney, Clyde G., February 23, 1945
Reed, Albert C., December 2, 1944*
Rogers, Alfred A., April 14, 1945
Ross, Frank E., June 23, 1944
Schweier, Arthur, May 18, 1945
Scribner, Charles W., March 31, 1945
Tefft, Ward, March 28, 1945*
Wiley, Edgar C., April 12, 1945
Zebine, Abraham S., May 10, 1944*

* Died in line of duty.

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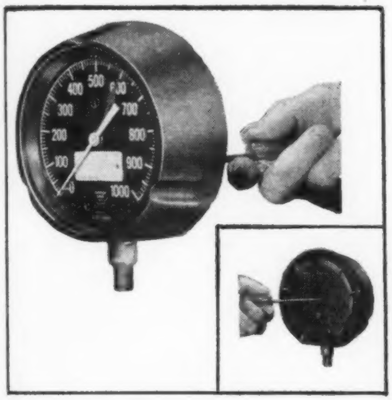
New Pointer Adjuster



Certified Gauge & Instrument Corp. of Long Island City 1, N. Y. announces that all Certified Pressure Gauges are now equipped with "Hairline Pointer Adjusters." With this new device, pointers can be quickly and easily reset without removing the glass or ring. Convenient when testing gauges on test pumps and dead weight testers.

Slotted adjusting screw in back of case changes the relative position of the roller and the cam of the Helicoid movement, thus changing the position of the pointer. Fine adjustment is obtained by slight turn of the screw.

Added Speed Provides Wider Use for Brown Electronics Recorders

Increased industrial use of electronic recorders has been made possible, it is announced by Brown Instrument Co., by stepping up chart speeds of Electronik Pyro-Potentiometers.

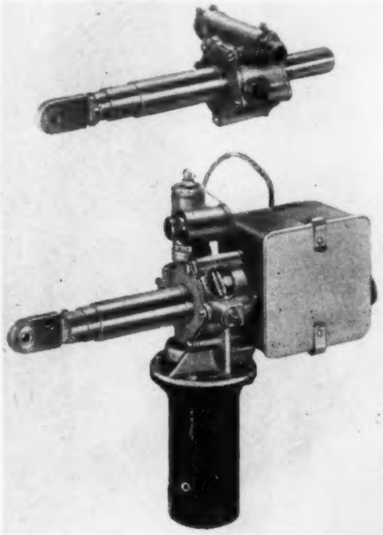
The standard speed electronic recorder, single or multiple point models, incorporate gear changes for speeds of 5, 10, 15 and 20 inches an hour, it was said at the Philadelphia division of Minneapolis-Honeywell Regulator Co.

Fast speed electronic models, single or multiple point, will have internally mounted gears for speeds of 10, 20, 30 and 40 inches an hour.

As shown in the accompanying illustration, the gears are changed by removing screw "C" from gears "A" and "B" and by lifting the gears from the assembly. The new speed gears are then installed and screw "C" is replaced.

Dual Linear Actuators

Dual operation is possible with these two linear actuators manufactured by Foote Bros. Gear & Machine Corp., Chicago 9, Ill. The primary actuator is powered by a $^1/_6$ HP electric motor. The secondary actuator (motorless type) gains its power from the primary by means of a flexible shaft coupling which syncronizes the two units.



Both actuators have a linear action of five inches at an extension speed of twelve seconds and a retraction speed of nine seconds. Travel of the screwjack is accurately controlled by limit switches and stops may be adjusted by a single screw. These two models are capable of handling working loads up to 750 pounds each with a static load capacity of 2500 pounds each.

The $^1/_6$ HP motor of the primary unit operates at 8000 RPM from 26 volts DC at maximum rated $11^1/_2$ amperes and is equipped with a magnetic brake for instantaneous stops and to prevent the gear train from creeping due to vibration of the plane.

Foote Bros. "A-Q" (Aircraft Quality) gears are used in these actuators. The primary reduction spur gears, steel worm and screwjack are heat treated to assure accuracy and long operating life. Steel parts are magnafluxed and all non-ferrous parts are X-ray inspected. Standard AN type electrical hardware is used.

Dimensions of the motorized actuator are 13 inches long, 11 inches high and $4^{15}/_{16}$ inches wide, weight 7 pounds 1 ounce. The shaft driven model is $10^{11}/_{16}$ inches long, $3^1/_2$ inches high, $3^3/_4$ inches wide and weighs 2 pounds 12 ounces. The latter may be used separately by driving off of any remote source of power.

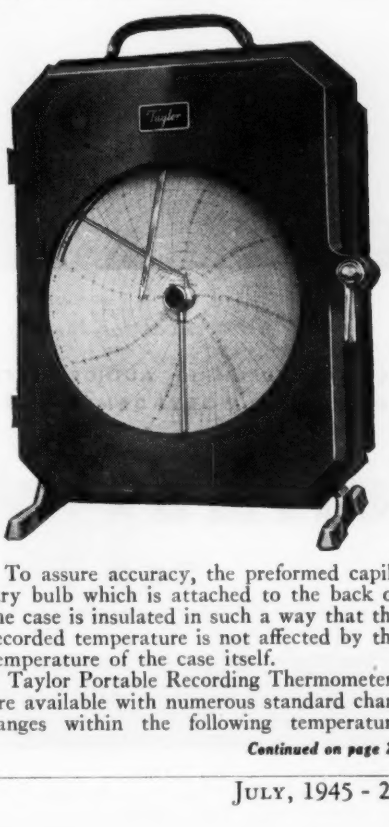
These two units, connected by a three foot flexible shaft, are used on the P-38 Lockheed "Lighting" to open and close the oil cooler flaps.

Foote Bros. offers an extensive line of motorized and shaft driven actuators for many aircraft and industrial uses. Additional information is available from Foote Bros. Gear & Machine Corp., Dept. NR, 5225 South Western Blvd., Chicago 9, Ill.

Portable Recording Thermometers Again Available

Suspended from the line for some time to permit mass production of more standard instruments for the war effort, the Taylor Portable Recording Thermometer is now back on the market. This self-contained unit is a standard Taylor Recorder except for the special temperature measuring system and the sturdy feet and carrying handle which have been added.

Originally designed for use in boiler rooms, enameling and japanning ovens, engine rooms, refrigerating rooms, brewery cellars, greenhouses, offices, etc., it has since found many useful applications in the chemical, food, and air conditioning fields.



To assure accuracy, the preformed capillary bulb which is attached to the back of the case is insulated in such a way that the recorded temperature is not affected by the temperature of the case itself.

Taylor Portable Recording Thermometers are available with numerous standard chart ranges within the following temperature

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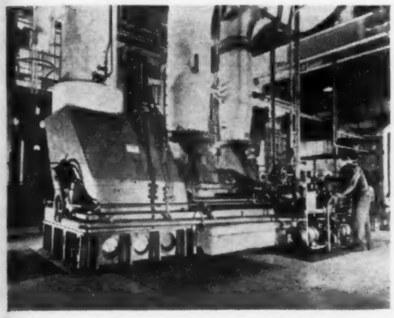
limits: mercury-actuated instant, minus 38° to plus 200° F. or equivalent C.; vapor-actuated, 0° to plus 300° F. or equivalent C. The instrument weighs 18 pounds and measures $20^1/_4''$ high, $13^3/_4''$ wide, and $6^3/_4''$ deep. Chart-driving mechanism can be supplied with periods of revolution to accommodate all regular recorder charts.

Further information may be obtained by writing to the Taylor Instrument Cos., 31 Ames Street, Rochester 1, New York.

One of 29 Allis-Chalmers Gas Turbines



Now performing successfully in the Houdry process for oil refinery service, this and a companion unit are producing 10,255 horsepower in a 100-octane gasoline plant in Ohio. Only land turbine application actually operating, the Houdry gas turbine unit is a forerunner of other important power plant uses in both land and marine fields. Allis-Chalmers, already has operating an experimental marine gas turbine designed and built as a part of an extensive development and research program, has announced complete designs for a 90-foot, 4800 horsepower gas turbine-driven railroad locomotive, and considers the "peak knocker" for electrical power systems quite promising for the not too distant future.

Stainless Steel Weighs Less than Aluminum

The Chicago Metal Hose Corp., manufacturers of both stainless steel and aluminum flexible tubing have just completed a series of analyses which reveals, among other facts, that stainless steel Rex-Flex is lighter weight than flexible aluminum. The following table gives a weight comparison:

Size	Rex-Flex* R.R. Wall Formation	Interlocked Aluminum Flexible Tubing
1″	.057	.1450
$1^1/_4$	.079	.1809
$1^1/_2$	.103	.2131
2	.151	.2743
$2^1/_2$	.205	.3812
3	.264	.4233
4	.403	.6016

* Rex-Flex is available in 5 wall formations.

As evidence that weight is still important, even in heavier planes, the Chicago Metal Hose Corp. points out that Rex-Flex has replaced aluminum flexible tubing for use in heavy bomber production where, in the form of tubing, it is used to conduct both heated and cooled air.

Non-Magnetic Uses of Manganese Steel

"Non-Magnetic Applications for Amsco Manganese Steel" is the title of the first comprehensive work published on that subject; a 32-page illustrated bulletin just issued by the American Manganese Steel Div. of American Brake Shoe Co., Chicago Heights, Ill.

Austenitic manganese steel has been widely adopted by industry during the past half-century for applications where high resistance to impact and abrasive wear is required. Important, but given less recognition until recent years, is the non-magnetic property of manganese steel. Ordinarily, nonferrous metals are adequate for such applications, but in an increasing number of cases the qualities of impact or abrasion resistance, or both, are essential for certain equipment parts requiring non-magnetism as well. In such cases the low strength, added to the high cost, of copper, brass, bronze and other nonferrous alloys makes them unsuitable, especially in the form of castings.

Austenitic manganese steel is an inexpensive but very strong and tough material for castings which must be substantially non-magnetic. Its permeability is so low that the attraction by a magnet is minute and generally is not detectable.

Presented in this bulletin are studies with illustrations of typical applications where non-magnetism and the ability to withstand shock and wear were equally vital factors in the selection of manganese steel. These applications include lifting-magnet cover plates, collector shoes, fingers for stator

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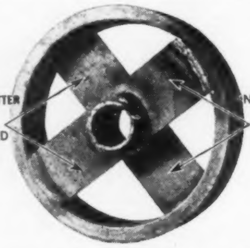
cores, magnetic separator drums and rollers, electric furnace parts, aircraft instrument testing devices and a number of railroad applications. These studies may point the way to the solution of many problems. The story of manganese steel and the company's research facilities are also covered in Bulletin 1144-N, which will be mailed on request.

"Non-Spatter" Welding Film Announced by Lincoln Electric

A liquid designed to minimize the adherence of welding spatter to metal and reduce cleaning time has been introduced by The Lincoln Electric Co., Cleveland, Ohio.



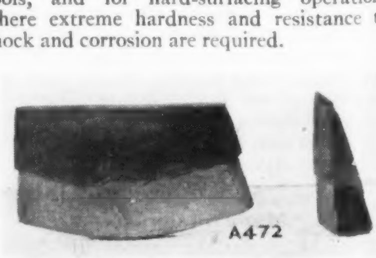
This new product which is priced at only a few cents a quart is known as Lincoln "Non-Spatter" Film. The liquid has been thoroughly tested in the field and found to possess the following characteristics: Welding can proceed after application, whether the film is still wet or dry. Film can be sprayed or painted on work. Priming coats of paint may be readily applied over the film. If it is desired to remove the film before painting, this can be readily accomplished by washing with water. One application of film is effective for multiple-pass welding. If film is sprayed or painted on parts prior to being normalized, the oxide film and ordinary scale can be removed more easily after heat treating. Material will freeze but freezing has no effect on its properties when thawed out.

Lincoln "Non-Spatter" Film is supplied in concentrated form in 5 gallon cans for the convenience of the user. By diluting the concentrated material with three parts of water, 20 gallons of film fluid is obtained.

Either brush or air gun can be used to apply the film to the areas adjacent to the joint to be welded and to welding jigs that may be subjected to spatter. After welding, the spatter can be easily removed by wiping or brushing, thus reducing cleaning time to a minimum.

New High Speed Steel Welding Rod

Bulletin 345-W on Amsco Toolface has just been issued by the American Manganese Steel Div. of American Brake Shoe Co., Chicago Heights, Ill. This new welding rod was developed to save time and reduce costs in making, salvaging and altering cutting tools, and for hard-surfacing operations where extreme hardness and resistance to shock and corrosion are required.



Toolface is a super-hard and tough alloy tool steel welding rod composed of high carbon, high chromium, high molybdenum, tungsten and vanadium; commonly known as high speed steel. Its welded deposits have

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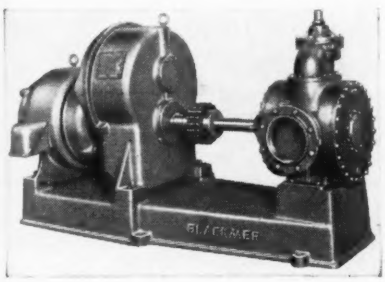
a Brinell hardness of 575 to 675, depending on the dilution of the metal.

Toolface is especially adapted for the production of composite cutting tools, including those used on lathes, shapers, milling heads, etc. Its ready weldability expedites the depositing of cutting edges or lands on mild steel bases or shanks. This method, plus its high degree of hardness and the ease with which Toolface cutting surfaces can be dressed, results in substantial economies in tool making. The bulletin pictures the four simple steps in making a composite high speed cutting tool with Toolface, using carbon steel as a base. Temperatures for various heat treatments for Toolface work are tabulated.

The accompanying illustration shows Toolface deposited on inexpensive carbon steel and forged to shape. It is noticeable that the line of fusion has not been affected by the forging operation. The specimens were etched in diluted hot sulphuric acid, so the resistance of Toolface to corrosion is apparent.

New Rotary Pump—Steam-Jacketed Head

A steam-jacketed rotary pumping unit of considerably improved design has been put into production by the Blackmer Pump Co., Grand Rapids, Michigan, according to an announcement by J. B. Trotman, General Sales Manager of the Company.



The new unit was designed for handling sludge and other viscous liquids. It has a capacity of 500 GPM at 150 psi pressure and is powered by a 75 HP gear-head motor with a speed of 155 RPM on the drive shaft. The pump construction is iron, bronze-fitted and the entire unit is mounted on a cast-iron base. The steam jackets are suitable for pressures up to 125 psi and are located on both heads.

Units in capacities of 50, 90 and 200 GPM, with gearhead motor or reduction gear drive are also available with steam-jacketed heads of this construction. All of the new units operate on the "bucket design," swinging vane principle, and are self-adjusting for wear.

Buffalo Forge Receives Fourth Star

Buffalo Forge Co., first manufacturer to receive the Army-Navy "E" for excellence in production of "Fans," and one of the earliest in the Niagara Frontier, has just been advised of the fourth renewal of that honor by the Navy Department.

Thousands of Buffalo axial flow and centrifugal ventilating fans are in use on Navy ships and on merchant marine vessels, and daily shipments to all branches of the maritime service continue.

Well fitted at the start of the War to swing into production for the Armed Forces "Buffalo" is equally well-fitted to resume production of civilian ventilating and air conditioning equipment when Japan is defeated.

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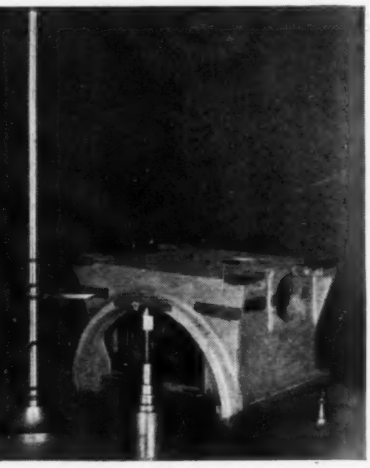
Multiple Height Gage

A multiple height gage designed by Charles Rohlfs of General Electric's Pittsfield Works inspection department has simplified scribing of gear housings and their inspection after machining, and considerably reduced layout time. Dial indicators can be clamped to the multiple scribers and set to required dimensions to inspect quantities of identical parts.



Relatively simple to make, the gage consists of a center column-rod threaded into the base and secured by a lock nut. The spacers and scribers, hardened and ground, are drilled to slide-fit the column rod. The spacers are ground to dimensions that will place the scribers correctly for the layout of the required lines for machining. After these are placed on the rod and correctly spaced, the assembly is secured by a cap nut. To compensate for the variations in unmachined castings, the complete assembly of spacers and scribers can be adjusted higher or lower, without disturbing any of the dimensions between the scribers, by loosening the lock nut and screwing the center column rod in or out of the base, as the case may be.

By using a set of spacers for each drawing, the scribers are easily spaced and secured, and any quantity of identical parts can be rapidly laid out. This new gage eliminates the use of the conventional gage, which had to be set for each line and the reading checked before scribing.

New Motor Design Gives Trouble Free Operation

A new feature in electric motor design, the prelubricated sealed ball bearing has been applied by Westinghouse engineers to eliminate the necessity for greasing except at intervals of five years or longer.

This new bearing consists of the standard single row of balls mounted in races of the same width as the double row ball bearings. Metal shields are anchored solidly in the

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outer race near the outer edges and extend down and inward to a close running clearance from the inner race. Adequate space for grease is thus provided and at the same time there are highly effective seals against the leakage of grease or the entrance of dirt.

This construction gives several operating advantages: the tightly-sealed enclosure reduces oxidation of the grease, thus promoting longer grease life; maintenance expense is sharply reduced as frequent greasing is not required; grease is kept in and dirt is kept out; when motors are disassembled the bearings, being enclosed in a cartridge are protected against dirt. Furthermore, the always present hazard of overgreasing and the consequent grease seepage into windings is eliminated.

Since 1939, thousands of lint free induction motors incorporating this feature have been installed throughout the textile industry. These have operated from three to six years, running twenty-four hours per day at higher room temperatures and at higher humidity than is encountered in most industrial applications. Their success has been outstanding. A few months ago, engineers inspected a large number of these bearings chosen at random from about 600 motors installed in six different southern cotton mills, all of which had operated at least four years, 24 hours a day, and none of which had ever been regreased. None showed any signs of wear and the grease was in good condition; all were reinstalled with the recommendation that they be run for another three-year period before being relubricated. Other applications of these bearings have been made with equal success.

The prelubricated sealed ball bearing construction will be added to other standard lines as war conditions permit.

Compact Device Facilitates Field Safety Tests for Cable

The Simplex Jenny Center Hole Hydraulic Puller, which is widely used for heavy duty pulling, pushing and lifting jobs, has recently made its bow in the field of tensile testing.

The picture shows a Model 10010 Simplex Jenny, of 100-tons capacity, testing a $1^1/_2''$ cable sling to 90,000 pounds. A clevis through the dead eye is secured to a long bolt which has been inserted through the Jenny and fastened above the cylindrical ram.

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The dial furnished with the unit accurately and constantly shows the pulling power applied, and consequently the tensile strength displayed by the member under test. This is a true operating tensile test, which many engineers prefer, with all due respect to modern day tensile testing equipment.

Available in five models of 30 to 100-tons capacity, the Jenny is well adapted for making tensile tests of cable, rods, hooks and other members which are subjected to tensional stresses. Ohe man is usually all that is necessary to operate the unit.

Bulletin 44J, giving complete details on the Simplex Jenny, will be mailed on request by Templeton, Kenly & Co., 1020 S. Central Ave., Chicago (44), Ill.

No Tie Rods Feature New Gerotor Air Cylinders

Contributing to the modern design of the new Gerotor double-acting, non-rotating Air Cylinders, just announced by Gerotor May Corp., Logansport, Ind., is the complete absence of tie rods. Keeper ring design, instead, assures leak-proof construction and permits covers to be rotated to any position for convenient location of pipe connections. Keeper ring construction also permits more compact design of the cylinder and allows it to be applied in a minimum of space.

Gerotor cylinders can be used for 150 lbs. air and 300 lbs. oil and water service. Those used for oil hydraulic service can be had with auto type piston ring construction.

Self-adjusting composition packings are used for cups and piston rod, and have been selected for the three services to provide long life and minimum friction.

Other Gerotor air cylinder features include: 1, large pipe connections; 2, ample bronze rod guide; 3, over-size alloy piston rod; 4, heavy duty piston assembly; 5, heavy duty alloy covers.

Gerotor double-acting, non-rotating air cylinders are offered in seven standard mountings, in twelve diameter bores, in any length of stroke.

For complete information about Geroto Air Cylinders and literature illustrating and describing them, write to Gerotor May Corp., 444 Tacoma Ave., Logansport, Ind., mentioning this magazine.

Sixth Award of the Navy "E" to Farrel-Birmingham Plants

For the sixth time in three years, the Navy Department has recognized the excellent production record of Farrel-Birmingham Co. plants at Ansonia and Derby, Conn. and Buffalo, N. Y. by the award of the Navy "E". Admiral C. C. Bloch, Chairman of the Navy Board for Production Awards, in a letter to Franklin Farrel, Jr., says:

"It is with heartiest congratulations that the Navy informs the men and women of Farrel-Birmingham Co. that a fifth renewal of the Navy 'E' award was granted your plants at the last meeting of the Navy Board

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for Production Awards. New flags with five stars affixed to each should reach your plants within a few days.

"This award, signified by the five stars to be displayed on your 'E' flags, is an indication that all of you have maintained the excellent record of production which merited your previous awards. Each and every one of you may well be proud of this high honor and inspiring record.

"The courageous men on the fighting fronts must have the necessary weapons with which to wage total war. These men appreciate the vital support of the men and women of the plants of Farrel-Birmingham Co., who have worked with such untiring efforts on the production front to support these needed war materials."

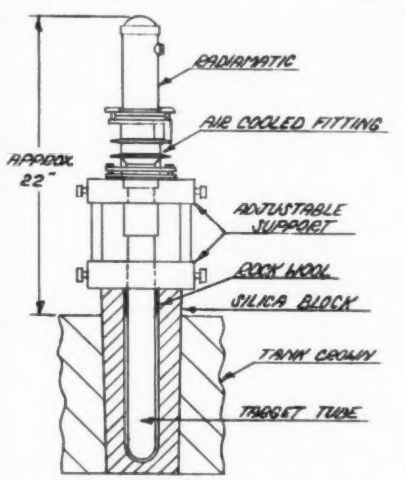
The "E" award, traditional Navy symbol for a job well done, was originally made to the three Farrel-Birmingham plants in Ansonia, Derby and Buffalo, in March, 1942, only three months after Pearl Harbor, and renewed in October 1942, March 1943, September 1943 and March 1944, each renewal adding another white star to the burgees which fly over the company's plants.

The Navy "E" is not only difficult to win, but the renewal stars are equally indicative of an outstanding production record. In addition to making marine gear drives for the Navy and Maritime Commission, the company builds heavy machinery for numerous war plants in the steel, non-ferrous metal, rubber, plastics, paper and other industries.

The Maritime "M" and Victory Fleet Flag were awarded the three plants last fall for their work for the Maritime Commission.

Brown Introduces New Silica Block For Radiamatics

A new silica block for measurement of crown temperatures in glass tanks has been developed for use with Radiamatics, radiation pyrometers, made by Brown Instrument Co., Philadelphia.



The new silica block is said to have three additional advantages, namely: 1. More constant calibration than is usually experienced with thermocouples. 2. More open scale divisions throughout the operating range. 3. Lower net cost. The increased service life of the Radiamatic and its new accessories will more than offset additional initial costs.

The single hole silica block, according to the Brown division of Minneapolis-Honeywell Regulator Company, is installed flush with inside roof surfaces. It is sometimes installed so that the bottom of the block

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extends into the furnace for several inches. The Radiamatic is sighted into an 18-inch Sillimanite target tube which is installed in the block to within one-quarter inch of the bottom. An air-cooled fitting only is necessary to prevent overheating of the Radiamatic under normal operating conditions. The target tube is maintained under a slight positive pressure by connecting to a low pressure air supply.

The Sillimanite target tube is accurately positioned by adjustment of the vertical support. The annular opening between the Sillimanite tube and the silica block is packed with rock wool or similar material to prevent accumulation of batch dust.

Third Army-Navy "E" Award to Aurora Pump Co.

Admiral C. C. Bloch, U.S.N. (Ret.), Chairman, Navy Board for Production Awards, has just advised Aurora Pump Co., Aurora, Illinois, of a second renewal of the Army-Navy "E" Award "for meritorious service on the production front.

"The men and women of your plant have continued to maintain the high standards they set for themselves when they were originally granted the Army-Navy "E" Award. They may well be proud of their achievement."

The raising of the new "E" Flag was marked by simple ceremonies emphasizing the loyal accomplishments of the plant personnel.

• *BUSINESS CHANGES*

General Electric Announces Plans for New Research Laboratory

A new building for the General Electric Co.'s Research Laboratory, which will afford some 50 per cent more space than present facilities provide, will be erected near here at a cost of $8,000,000, it was announced recently by President Charles E. Wilson. Construction will begin as soon as WPB approval can be obtained.

The site has been a private estate known as "The Knolls," and includes 219 acres. It is in suburban Niskayuna, about $4^1/_2$ miles from the main plant and offices in Schenectady. Overlooking the Mohawk River, it is on a rocky cliff which will afford an excellent and solid foundation for the laboratory buildings. The river at this point forms part of the New York State Barge Canal, and the Troy branch of the New York Central runs along the bank, so there will be ample water and rail transportation available. In addition the river will afford a good supply of water for laboratory use.

"The two buildings now occupied by the Laboratory were built in 1914 and 1922," said Dr. C. G. Suits, G-E Vice President and Director of Research, "and while they were the last word in laboratory construction then, this is no longer true. For some time we have been cramped for space and this condition has been aggravated in the past few years when all our facilities have been devoted to war work. We have a very much expanded program for the postwar years, which will increase our staff from its present 540 to about 800.

"We must look ahead even 15 or 20 years beyond this, when still further expansion may be required. We will probably need to build smaller structures for special purposes, for example, a pilot plant for a new chemical process. All this requires not only a building that is immediately suitable,

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but one to which we can add and with ample grounds around it for the other buildings.

"Lack of space adjacent to the Schenectady Works, as a result of wartime construction which has utilized all prospective building sites, has forced a consideration of other locations. The one selected, in Niskayuna, and the laboratory building that we are planning, will meet these needs ideally. Every new and modern feature will be incorporated and I feel confident that we will have one of the finest and most complete research institutions in the world."

The new building, in the general shape of the letter T, will vary from two to five stories in height and will include 200,000 square feet of laboratory working space in addition to an auditorium seating 300, a dining room, conference rooms, etc. One third of the laboratory space will be devoted to service facilities, machine shops and specialty shops such as glass blowers, all in a convenient central location.

Walls between rooms will be movable, capable of being placed at 18-inch intervals so that rooms may easily be made large or small as desired. Benches and all furnishings will be standardized so that they can easily be shifted from place to place as the need arises. The building will be air-conditioned throughout. Wires and pipes carrying various kinds and voltages of electricity, compressed air, suction, illuminating gas, hydrogen, oxygen, etc., will interlace the building whence they can be brought into any room.

The high elevation of the site above the river will afford many advantages, for example, in experiments with radar, high frequency jet engines. The rocky cliff foundation will be useful in conducting experiments with X rays. These are being produced at 100 million volts in the present laboratory, and further increases are expected.

Ricker New General Superintendent at Kropp Forge

John E. Ricker, recently appointed general superintendent at Kropp Forge Co., Chicago, is well qualified by more than twenty years of experience in metallurgical research and all phases of forgings production for his part in the completion of the plant's war production program and its reconversion to peacetime output.

Ricker's early training in metallurgy was obtained in the research department of Republic Steel Corp. Subsequently, he was for some eight years chief metallurgist for the Canton Drop Forge & Mfg. Co. of Canton, Ohio, and later for seven years was with the Steel Improvement & Forge Co. of Cleveland, Ohio.

During most of the present war period, he has again been with Republic Steel, in the field service metallurgical department, until he was called to his present position.

Denison Engineering Names Two Vice-Presidents

William C. Denison, Jr., president of The Denison Engineering Co., Columbus, Ohio, has announced that at a recent meeting, the company's Board of Directors named two of its executives vice-presidents and advanced a third to a newly created position.

Lonnis Denison, formerly assistant general manager, was appointed Vice-President and Assistant General Manager, Frank C. Norris, formerly Director of Production, was made Vice-President in Charge of Manufacturing and Engineering. Mr. Lonnis Denison has been active in the company's management since 1942, having first served

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as Assistant Production Manager, then as Manager of the company's Research Laboratory, and later as Acting Director of Engineering and member of the Management Committee.

Mr. Norris has been associated with the Denison organization since its inception at Delaware, Ohio. Starting as a lathe operator for the Cook Motor Co., which was later purchased by the Denison organization, he advanced as the company grew, successively serving as service representative, plant superintendent, general superintendent and assistant general manager. He held the position of vice-president and general manager of the Budd-Ranney Engineering Co. when that company became a totally-owned subsidiary of the Denison Engineering Co.

At the same meeting, E. L. Fouse, of the company's accounting department, was named Manager of Expense Control. Mr. Fouse joined the company in 1942 as Assistant Chief Cost Accountant and, prior to his recent advancement, served as Chief Cost Accountant.

In announcing these appointments, it was stated by W. C. Denison that they were being made in order to further increase management efficiencies in the design, manufacture and sale of the company's already well-known products and its new developments in the field of oil-hydraulic equipment and machinery, including its new "Multipress," a many-purpose machine tool which features a revolutionary principle of vibratory hydraulic action invented by Denison engineers.

Plier Now Assistant General Manager of D. J. Murray

Arnold W. Plier has been named Assistant General Manager in charge of production of the D. J. Murray Manufacturing Co., Wausau, Wisconsin, according to a recent announcement from the company. In March Mr. Plier was elected Secretary of the company. His present position is additional duties in which he will direct all work pertaining to production.

Mr. Plier has been with D. J. Murray Manufacturing Co., since 1930, in the Cost and Production Departments. Prior to that time, he was employed for a number of years in the Cost and Production Departments of several Wisconsin paper mills.

Remmers Now Vice-President of Electro Metallurgical

New York—W. E. Remmers has been elected Vice-President of Electro Metallurgical Co., a Unit of Union Carbide & Carbon Corp.

Mr. Remmers was graduated from the School of Mines and Metallurgy, University of Missouri, in 1923, received the Masters' degree the next year and later the Degree of Metallurgical Engineer. After a number of years devoted to research and operating ex-

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perience in iron and steel, he joined Electro Metallurgical Sales Corp. at Chicago in 1936, and soon became District Manager and later Division Manager. He was transferred to the New York Office in 1941 and in 1944, he was elected Vice-President of Electro Metallurgical Sales Corp.

William A. Elliott Elected Executive Vice President

William A. Elliott, newly elected executive vice president of Elliott Co., is a native of Pittsburgh and received his degree of Bachelor of Science in Electrical Engineering at Penn State, class of 1928.

Mr. Elliott entered the Ridgway plant of Elliott Co. following his graduation from Penn State, and spent two years in motor and generator design, followed by ten years of sales work in the company's Atlanta, New York, Cincinnati and Chicago offices, being manager of the latter two offices. In 1941 he was made vice president in charge of governmental relations, and became sales vice president in 1943. He is also a member of the Board of Directors of Elliott Co.

H. K. Porter Co. Appoints Comstock

H. K. Porter Co., Inc. has appointed John A. Comstock as Director of Research and Metallurgy for all Porter Divisions.

He will be in charge of the central Research and Testing Laboratory located in Pittsburgh. Individual laboratories for plant control will be located at McKeesport, Pa., Newark, N. J., and Mt. Vernon, Illinois.

While Mr. Comstock will maintain technical advisory service for customers on materials and metallurgy, his prime purpose is to develop new and improved products in the varied Porter lines, as stated by T. M. Evans, President of H. K. Porter Co., Inc.

Previous to his affiliation with Porter, Mr. Comstock served as Engineering Metallurgist with the United Aircraft Corp. of East Hartford, Conn. He has had directive experience with several concerns including Peoples Gas Company, Chicago, in metallurgical and materials processing lines.

A graduate of the University of Illinois, Mr. Comstock holds a Bachelor of Science Degree in Metallurgy and Engineering and is an active member of the American Society for Metals. He served as Secretary and Treasurer of the Chicago Chapter for seven years.

Kessler to Represent Farrel-Birmingham in Midwest

Farrel-Birmingham Co., Inc. has announced the appointment of Armin G. Kessler as manager of sales of the midwestern district with headquarters in Akron, Ohio.

Mr. Kessler first came to Farrel-Birmingham in 1920 as general manager of the company's plant in Buffalo, N. Y. He has been a vice-president and director of the firm since 1923, and prior to the present appointment was general works manager of the three Farrel plants in Ansonia and Derby, Conn., and Buffalo, N. Y.

Born in Syracuse, N. Y., Mr. Kessler received his early education in the public schools of Oswego, N. Y., and was graduated from Cornell University in 1908, receiving his master's degree in mechanical engineering in 1910.

As Lieutenant, USNRF, he served on board the USS Connecticut during the first part of World War I, and later was Assistant Chief, Gun Division, U. S. Navy Ordnance Department, Washington, D. C.

After leaving the Navy in 1919, he was vice-president of General Ordnance Co., Derby, Conn., until he became associated with Farrel-Birmingham in 1920.

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McManigal Elected Vice President of Westinghouse Electric International

Election of Robert D. McManigal as a Vice President was announced recently by John W. White, President of the Westinghouse Electric International Co.

Mr. McManigal, whose office is at New York, has been manager of the International Co.'s Associated Companies Department since 1940.

He joined the Westinghouse Electric Corp. at Pittsburgh in 1915 as a member of the graduate student course, following his graduation as an electrical engineer from Lafayette College at Easton, Pa. In 1922 he was sent to Japan as an engineer for the Westinghouse Electric International Co., and later served as managing director of the Westinghouse Electric Company of Japan until that Company's dissolution in 1931, when he returned to New York.

Since 1931, Mr. McManigal has been, successively, manager of the Central Station-Transportation Apparatus Department, assistant to the Vice President, and finally manager of the Associated Companies Department, his present post.

Briggs Clarifier Appoints Garrard Chief Engineer

Briggs Clarifier Co. of Washington, D. C., and Bethesda, Md., has just announced the appointment of George S. Garrard as Chief Engineer.

Mr. Garrard, who has had wide experience in aviation and industrial engineering, goes to the Briggs post from Jacobs Aircraft Engine Co. of Pottstown, Pa., where he was Assistant Chief Engineer in charge of all engineering branches. The Jacobs plant produced Pratt and Whitney aircraft engines under license agreement.

Prior to joining the Jacobs staff, Mr. Garrard was Design Analyst for the Pratt and Whitney Aircraft Corp. of East Hartford, Conn.

Mr. Garrard attended McKinley Tech High School in Washington, D. C., Emmerich Manual Training High School of Indianapolis, and Purdue University.

Morse Chain Co. Appointments

Appointment of Frank M. Hawley as vice president and general manager, and his election to the board of directors, is announced by the directors of Morse Chain Co., Ithaca, N. Y., and Detroit, Mich., manufacturers of chain drives and power transmission equipment, division of Borg-Warner Corp.

Mr. Hawley, formerly manager of the Detroit plant, has been associated with Morse Chain since 1919. He continues as a vice president of the company. He succeeds C. J. Kenerson, who retires as active head and continues as a director and vice president. Stanley B. Waring, former secretary, was elected secretary and treasurer.

Announcement also was made that expansion costing upwards of one million dollars would be started at the Ithaca, N. Y., plant, anticipating substantially increased postwar demand for the company's products.

• LATEST CATALOGS

New Catalog Describes All De Laval Products

The De Laval Steam Turbine Co. has issued a new catalog devoted to the complete line of Steam Turbines, Helical Gears, Centrifugal Pumps, Centrifugal Compressors, Worm Gear Speed Reducers, and IMO Oil Pumps made by that company. In addition to briefly describing the equipment, this catalog tells something of the more noteworthy achievements of the company, particularly in the development of high pressure marine propulsion units and in the introduction of centrifugal pumps for water works service. Copies of the catalog may be had by asking for Catalog 1181. De Laval Steam Turbine Co., Trenton 2, New Jersey.

New Booklet on Steel Forgings by National Forge

"How long is it since you visited a modern forge plant?" That is the challenging thought expressed at the start of the new booklet being presented to users of heavy duty steel forgings by the National Forge & Ordnance Co. And this thought of going through a forging plant keynotes the entire contents of the book, which is planned to bring the highpoints of such a trip to the reader who does not have the time or opportunity to visit the plant in person.

The basic operations of making a finished steel forging, as carried on at National Forge, are covered with a great deal of pictorial emphasis. The many "on the spot" photographs which illustrate the entire book give one the feeling of being

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within the large National Forge plant, for they parallel the progress of a forging from the making of the electric steel through the forgesmithing and heat treating to the finish machining.

The facts that naturally go with such pictures are presented in a forthright, unadorned manner which makes the book all the more helpful to buyers and users of steel forgings. To obtain a free copy, simply address the National Forge & Ordnance Co., Irvine, Warren County, Pa. and mention this magazine.

Control of Harmful Drop Hammer Vibration Explained

The control of harmful vibration from drop hammers, punch presses and other impact machinery through the use of Korfund vibration isolating equipment is the subject of a new 12-page bulletin recently published by The Korfund Co., Inc., of Long Island City 1, N. Y.

The bulletin points out that unchecked vibration from this type of heavy machinery can crack firebrick and loosen refractory linings in nearby furnaces, weaken building walls and ceilings, destroy the accuracy of adjacent precision machinery, impair the health and efficiency of workers, and shorten the useful life of the impact machine itself. Photographs and drawings show how these costly effects can be permanently eliminated by mounting the machines on steel spring isolators.

The methods developed by Korfund for suspending entire concrete foundation blocks on vibration isolation equipment are explained and illustrated. For those machines which do not require concrete inertia blocks, a simpler type of installation, with the machine mounted directly on isolators, is described.

Copies of this bulletin can be obtained by sending a request on your letterhead to The Korfund Co., Inc., 48-15 Thirty-second Pl., Long Island City 1, N. Y.

Bearing Application

New Departure announces a new book in its series of treatises for designers, on the fundamentals of ball bearings—entitled, "Bearing Application."

With 78 drawings and charts and a clear and orderly description, the book covers among other subjects the most important fundamentals of bearing mounting applicable to all types; preloading methods, their effect on housing fits, the effect of press fits on preloading, the effect of preloading on bearing life; bearing creep, the use of duplex, shield and sealed bearings, etc.

Copies may be obtained free from the Advertising Department of New Departure, Division of General Motors Corporation, Bristol, Connecticut, by specifying booklet BA.

A companion book entitled, "Details of Design," issued last year and covering the details of shaft and housing design for ball bearings will also be supplied to those who have not already received a copy.

Die-Less Duplicating

O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn. has just issued an entirely new edition of their catalog, entitled, "The Di-Acro System of Die-Less Duplicating," which is just off the press.

This new 40-page booklet contains illustrations and information concerning the latest models of all "Di-Acro" Precision Machines.

A major improvement, that they are just announcing, is the use of Torrington Roller Bearings in all sizes of "Di-Acro"

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Benders which has greatly increased the capacity and ease of operation of these machines over previous models.

One of the valuable features of all "Di-Acro" Benders is that they will form a completely centered eye, containing two bends, in one forming cycle. On page 13 of this new catalog are shown six photographs which illustrate this forming sequence.

"Di-Acro" Precision Machines are being effectively employed in war production by manufacturers in the radio, electronic, instrument, aircraft, machine tool and general manufacturing fields.

Since these flexible machines have such a wide variety of applications they will be extremely valuable during the conversion period as their universality will allow them to be readily converted from war to peace time production.

Midget "Megger" Insulation Tester

James G. Biddle Co., 1211–13 Arch St., Philadelphia, Pa., announces a bulletin just issued describing their Midget "Megger" Insulation Tester as now made in U.S.A. This new U.S. instrument now being built in their Philadelphia factory is identical in design and similar in every way to the made-in-England model that they have supplied for the past ten years, except that the molded plastic housing is mottled brown instead of red.

These popular instruments for testing insulation resistance have self-contained hand generators which are always ready for use and which develop as much as 500 volts d-c. Ranges extend to 50 megohms using the "Megger" cross-coil true ohmmeter that is independent of the generator voltage or speed of the hand crank. The instrument weighs only 3 lbs. and is small enough to be carried in an overcoat pocket.

Bulletin No. 1785 will be sent gladly upon request.

Marking Equipment and Industrial Inks

Louis Melind Co., 362 West Chicago Ave., Chicago 10, Ill., has just issued a new catalog of more than a thousand units of marking equipment and industrial inks, including their complete line of drawing inks. A request addressed to their Chicago, New York or San Francisco office will bring a copy, at no charge, to anyone who purchases material of this type.

Motorized Speed Reducers

Philadelphia Gear Works, Philadelphia, Pa. is offering a new 52-page catalog, No. MR-45, which describes their entire line of self-contained motorized speed reducing units. These Units are built in a wide variety of sizes and ratios, in both Horizontal and Vertical types. Complete engineering data is contained in this new catalog.

Glossary of Forging Terms

The forging industry, like most others, has its own language—its distinctive terminology. Some of the words are centuries old; others have come into use within relatively recent years.

To aid users and buyers of forgings toward a better knowledge of forging practice, the Kropp Forge Co. has compiled a comprehensive list of forging terms with their correct definitions and published them in a 20-page illustrated booklet entitled, "Glossary of Forging Terms."

In this booklet words and terms are defined as used in forging practice, and it is recognized that other definitions are employed for some of the words in other fields for describing identical processes or operations.

A copy of this Glossary of Forging Terms may be obtained by forging users on request from the Kropp Forge Co., 5301 W. Roosevelt Road, Chicago 50, Ill.

Lubrication Service Handbook

Lubriplate Division, Fiske Brothers Refining Co., 129 Lockwood St., Newark 5, N. J., have prepared for distribution their new 1945 Lubriplate Service Handbook.

This new book contains much valuable information on the subject of lubrication and will prove of considerable interest.

Corrosion in Unit Heaters

D. J. Murray Manufacturing Co., Wausau, Wisconsin—12-page booklet describing corrosion and its influence on unit heaters and their efficient operation. Contains technical information under various headings as "What Is Corrosion," "What Prevents Corrosion," "One Metal (Cast Iron) Resists Corrosion," "What Metals Are Vulnerable to Corrosion," "Where Certain Metals Should Not Be Used," "Selection of Proper Unit as Important as Machinery for Production Line." Contains illustrations of cast iron "fin" type unit heaters and installation views.